POWER PLANT ENGINEERING

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Pacific Countries Demand American Machinery

SURVEY OF RAPIDLY DEVELOPING INDUSTRIES IN VARIOUS PACIFIC COAST COUNTRIES REQUIRING POWER PLANT MACHINERY FOR EXPANSION. BY CHARLES W. GEIGER

AT THE PRESENT TIME the greatest demand for power plants is in the Hawaiian Islands, and the Philippine Islands. The Hawaiian Islands need plants for operating the pineapple canning plants and the sugar mills, and the Philippine Islands need power plants for operating the sugar mills and the cocoanut oil mills.

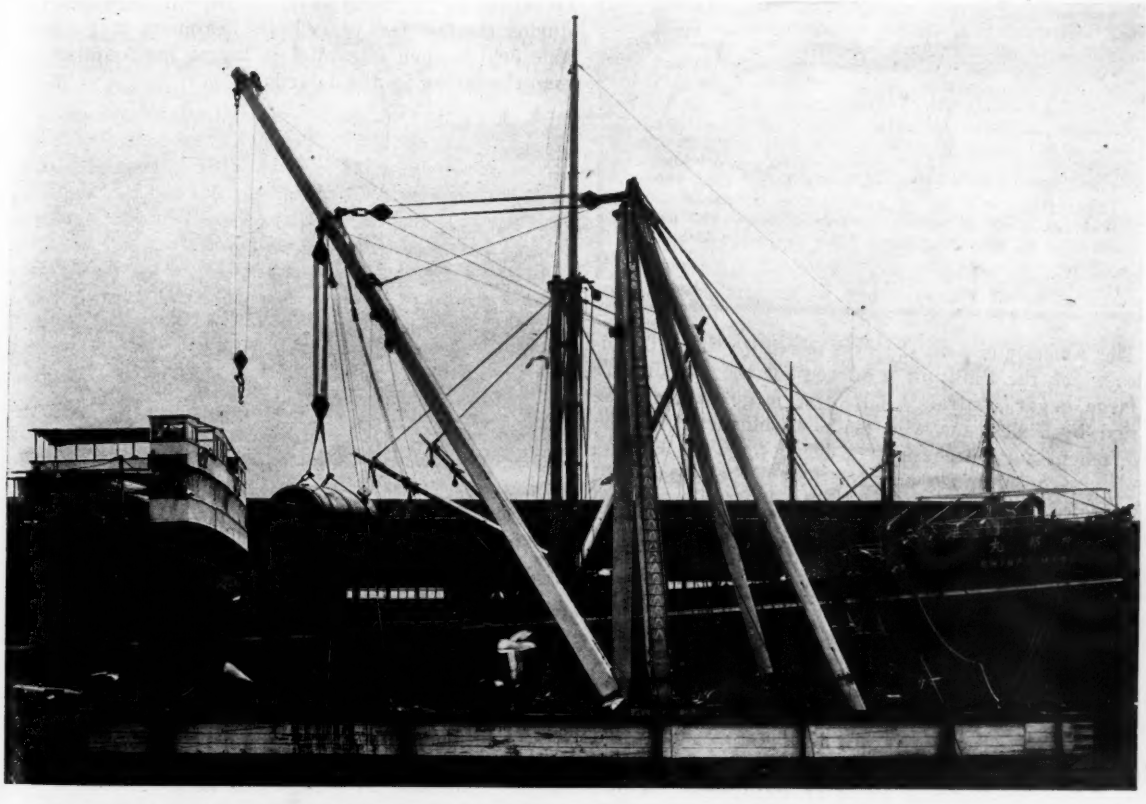


FIG. 1. LOADING A 42-TON BOILER ONTO A JAPANESE STEAMER FOR SHIPMENT TO JAPAN

A large number of American built Corliss engines have passed through the San Francisco docks for shipment to both the Hawaiian Islands and the Philippine Islands. There are a large number of these engines in use in the Islands. Three were shipped just lately. The engines are used in the sugar mills, being connected through a train of gears to the rolls used for crushing the cane. They operate at from 110 to 125 lb. steam pressure and against a back pressure of from 6 to 10 lb., the exhaust steam being used in the boiling house for the evaporation process.

The sugar industry is now the third largest industry in the Philippines, and it might be of interest to know something of the rise of this industry. The sugar cane and the industry to manufacture sugar from cane was brought to the Philippines by Chinese. The real importance of the Philippines as a sugar producing country dates from the year 1849 when the Spanish Governor

General put the Island of Negros under the jurisdiction of the clerical order of the Recolectos. This order encouraged the sugar industry and another encouragement was given by the Crimean war, which caused the price of sugar to soar and made the cultivation of sugar cane and manufacture of sugar for export profitable.

Another great help was the Payne-Aldrich bill of 1909 providing free entry for 300,000 tons of Philippine sugar annually into the United States. The Underwood bill has since admitted all sugars produced in the Philippines free of duty in the United States.

Sources of Information for Survey

During the past two years, Mr. Geiger has spent considerable time on the water front at San Francisco, for the exclusive purpose of compiling data pertaining to the commerce leaving and entering this port for and from the various countries on the Pacific, as well as the Hawaiian Islands, Philippines and Alaska. While engaged in this work a special effort was made to obtain photographs and data on the various shipments of power plant equipment passing through San Francisco enroute to the countries on the Pacific. Officers on the trans-Pacific steamers which carried the power plant equipment to the Orient were interviewed, also steamship officials, in regard to the use of the equipment, and with special reference to the opportunities offered American manufacturers in the countries on the Pacific. Weekly meetings of the San Francisco Foreign Trade Club were attended during the past two years, at which nearly one hundred persons (all of whom had traveled throughout the Orient and were thoroughly familiar with conditions there) spoke on the opportunities offered American manufacturers and exporters in the Orient. In this article Mr. Geiger gives a summary of all the information gained through these and other sources, with the belief that this information will be of great value to American manufacturers of power plant machinery, who are desirous of extending their business in the Orient.

The Americans were the first to realize the opportunities which the Philippines offered for the establishing of large sugar centrals. The first large central was erected by Americans who made a contract with the Government for purchase of a large tract of land on the Island of Mindoro and the first large sugar mill was erected in 1910, the company cultivating its own cane. This first mill, which was capable of crushing 800 tons of cane per day, was followed by another large mill on the Island of Luzon by an American corporation. This mill crushed the first crop in 1912—having a great amount of cane under own cultivation besides milling great quantities of cane from individual planters. This mill was extended considerably and is at present the largest on the island and capable of crushing 1800 tons in 24 hr. These were followed by others and a great stimulus was given when in 1915 a law was passed authorizing the National Bank of Philippines to give practically unlimited credit for erection of sugar mills against mortgages on machinery and farms and the first centrals, thus financed, partly consisting of old machinery was ordered for the Isabella district and was soon followed by orders for a string of large new centrals, most of them for Negros, and ranging in capacity from 600 to 1500 tons of cane for 24 hr., and all designed for doubling.

The following list gives the centrifugal sugar factories at present working or building in the Philippines: Capacity in tons: one, 1800; two, 1500; three, 1000; two, 800; one, 500; two, 300; two, 250; one, 200; one, 150; one, 125; four, 100; four 90; one 50.

All the large mills are of American manufacture. All these mills are similar in type to the Hawaiian factories which are so successful in operation.

There can be no doubt that the cane sugar industry will develop in the near future with giant strides, both through expansion of existing or building mills and through the building of new mills.

Cocoanut Oil Mills

The introduction of cocoanut oil mills in the Philippines during the past few years has created a very large demand for power plant equipment. As far as the writer could ascertain, all plants installed in the Philippines for the cocoanut oil trade operate the machinery by electric motor. The production of cocoanut oil in the Philippines has increased to such an extent that the exportation of the oil at the present time ranks first among the leading exports. In 1913, there was one cocoanut oil mill in operation in the Islands; today, there are 46 mills.

The notable success achieved by those who have embarked in the cocoanut oil industry in the Philippines during the last few years bears testimony that a profitable field is open to capital in laying the foundation of manufacturing in the Islands.

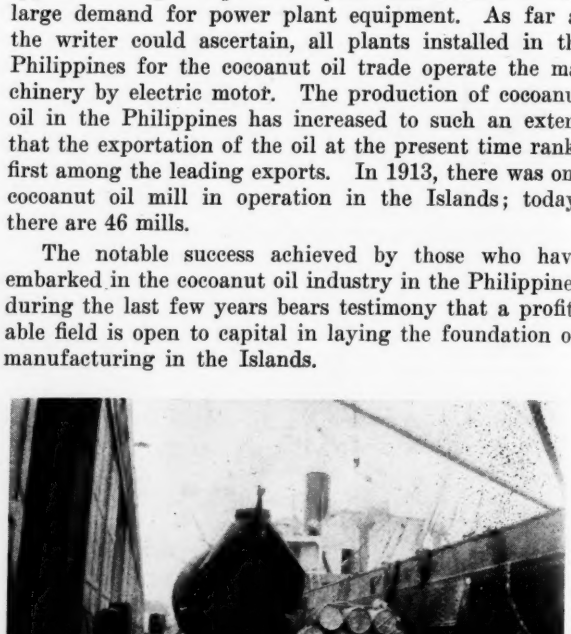


FIG. 2. INTERNALLY FIRED BOILER READY FOR SHIPMENT TO THE PHILIPPINES

For years, the product of the cocoanut groves found its way in the world's market in the form of copra, undergoing in Europe and America the process required to convert it into oil. The cost of transportation in the more bulky form of copra and the deterioration to which this commodity was subject during the transit and while stored awaiting conversion into oil, was a serious burden on the cocoanut industry from which the cocoanut-oil mills established in the Islands have relieved it. The country's returns from its cocoanut industry have been immensely increased by the establishment of these mills and, incidentally, this immense increase has passed through the coffers of those who established those mills and the labor engaged in operating them.

The great success of the various oil-mills was due to the natural advantages possessed by oil shipments over copra. Barreled oil takes up much less bulk space than

that required for copra based on oil content, and this enjoys a lower freight rate. Oil can be shipped on any steamer, whereas passenger vessels can not accept copra because of the objectionable odor. There is less loss in handling the raw material and a better grade of oil is obtained.

Soon after the beginning of the war when the demand for cocoanut oil became so great, the directors of the Philippine Vegetable Oil Co. obtained the services of an engineer, and ordered him to draw up plans for a million dollar plant. It made no particular difference how much it was going to cost, they said, but hurry. New York was demanding glycerine for munitions and the world wanted fats.

New machinery was ordered in large quantities and the company placed agents throughout the Islands with orders to buy everything that looked like a cocoanut.

One day it suddenly occurred to the engineer in charge of the construction of the plant that something might go wrong with the City Power Plant some day and it gave him a chill to think of the possibility that the grinders and cookers, expellers and filters might lie idle for want of electricity. So it was decided that they would have to have their own power plant. The generators were then ordered from the States and in the meantime a power plant was built. The company now has one of the best power plants in the Islands.

Some idea may be gained of the great increase in the manufacture of cocoanut oil during the past few years, when it is known that oil to the value of $1,146,183 was manufactured in the Islands during the year 1914; during 1915, it had increased to $2,619,183; during 1916, $3,925,734; during 1917, $11,409,147, and during 1918, a total of $31,664,159 or nearly 30 times the amount manufactured in 1914. In 1919 oil exported totaled 73,719,504 pesos, making this the largest item of export for the year, the second largest item being hemp, which amounted to 53,723,052 pesos.

There are no barriers in the Philippines to American firms. "While trade in Java, China and Japan has been quite active, yet it has been greatly hampered by all kinds of difficulties, such as money exchanges and difficulty in getting deliveries, while in the Philippines none of these troubles were encountered," writes an experienced American exporter seeking further connections in the Philippines. This man had done some business in the Islands and found it like transacting business with his own people at home.

Here is an important point American merchants should bear in mind. The Philippine market is practically a domestic market. There is no barrier of language to hamper. The question of exchange is negligible. Money values are computed from the same unit that obtains in the United States. The market is open, friendly and altogether agreeable and conciliating to the American concerns. There is every reason why American business men should go after that portion of Philippine trade that still flows through foreign channels, and especially after that great potential Philippine trade that is just around the corner of the future.

The Philippine business will inevitably go to those American firms who have put themselves in the way of it by getting in touch with Philippine traders, studying the Philippine buying public and making ready to give it what it demands.

The Hawaiian Islands are also most favorable to American firms. Hardly a steamer clears from San Francisco for the Hawaiian Islands without taking some power plant equipment, for the sugar mills, pineapple canning plants, etc. The Islands now produce approximately 600,000 tons of sugar a year. One of the leading firms in the Islands engaged in the building of sugar mills is the Honolulu Iron Works. Large quantities of cargo consisting of power plant equipment and machinery can nearly always be seen on the San Francisco piers, consigned to this firm.

One of the largest demands is for pineapple canning plant equipment. As the pineapple canning industry is of recent growth in the Hawaiian Islands, all the factories and equipment are not only new but are of the most modern construction, with machinery of up to date pattern. The size of the original plants in some cases has been doubled and even quadrupled.

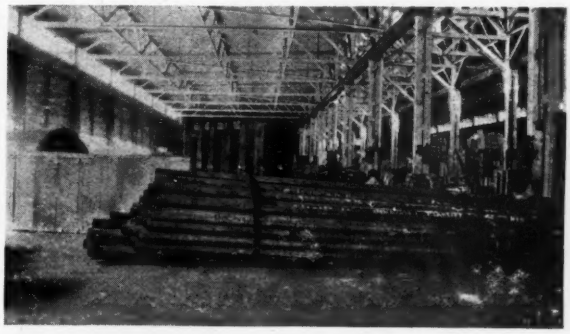


FIG. 3. BOILER TUBES READY FOR SHIPMENT TO HAWAIIAN ISLANDS; GREAT QUANTITIES OF THESE ARE CONSTANTLY BEING SHIPPED FOR USE IN POWER PLANTS OF SUGAR PLANTATIONS

The first factories were erected in the pineapple district. This was and still is satisfactory to several companies, but the completion of the railroad from the Wahiawa pineapple district to Honolulu in 1907 made possible the establishment of factories at the shipping port, where labor is more plentiful. As a result, numerous factories have been built at Honolulu since that date. At the present time, there is under construction a $125,000 pineapple canning plant, all materials for which are going from the States. The construction includes a modern power plant for supplying all power for operating the plant and all steam for cooking. This construction includes the development of a water system from the adjacent mountains and the construction of large fuel oil storage reservoirs, for taking care of the fuel oil for the power plant.

Pineapples were grown in a small way in the Hawaiian Islands about 1890, but no canning was done until 1900. In 1901, 2000 cases were canned; in 1907, it had increased to 186,300 cases for the year; in 1912, the output of the canning plants was 1,200,000; it is estimated that 6,000,000 cases will be canned during the coming season, the pack for last season amounting to over 5,000,000 cases.

At the present time, there are great opportunities for

American firms in the Dutch East Indies, for supplying power plant equipment for the larger mills and the cocoanut oil mills. John A. Fowler, United States trade commissioner at the Dutch East Indies, says in a report to the Bureau of Foreign and Domestic Commerce, that there is an expressed desire on the part of large oil mills that they be furnished with catalogs and prices for machinery and supplies by manufacturers of oil-pressing machinery, and pipe and pipe fittings, and by general machine supply houses of the United States.

One of the largest institutions in the Dutch East Indies is the Oliefabriken "Insulinde" Oil Mill. The islands, like the Philippines, have always been large producers of copra. Up until recent years, the copra was shipped out; but like the various concerns in the Philippines, the concerns that handled practically the entire output of copra decided to build mills in the Islands for pressing oil from the copra. The oil is now being delivered to San Francisco in great quantities, being carried in bulk in the steamers of the Java Pacific line, and delivered into the oil storage tanks located at Oakland on the San Francisco bay. Because of the

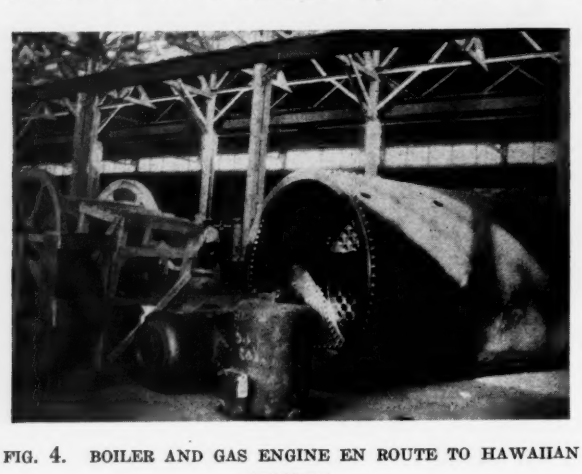


FIG. 4. BOILER AND GAS ENGINE EN ROUTE TO HAWAIIAN ISLANDS

ease in obtaining oil in the Islands, Diesel engines are used extensively in operating the machinery. These plants furnish a large market for American engines and oil pressing machinery. In shipping to the Dutch East Indies, manufacturers should take special pains to avoid the following possible criticisms:

Sending several machines to the same plant not all of the same type, which makes an interchange of parts in the case of breakage impossible.

Sending an engine too light in construction, for such a machine does not satisfy the workmen and causes their complaint that the machines do not run lightly.

Sending an entirely new type of engine for heavy duty, such as a difficult mountain run, which causes trouble at first in adjusting the machine to the work and may establish a more or less lasting prejudice against the American machine.

Large quantities of equipment for oil wells, oil well pumping equipment and oil refinery equipment are shipped out from San Francisco on the steamers of the Java Pacific steamer line running direct from San Francisco to Dutch East Indian ports.

Added evidence of the interest which the Dutch East Indies are taking in the growth of their trade with the United States, an interest which they recently made evident by sending as special trade commissioner to this country K. L. Van den Berg, managing director of the Bank of Java, is to be found in the recent official report of A. E. Carleton, United States Consul at Medan, Sumatra, giving the latest figures of American machinery and tool trade with the Sumatra East Coast.

Before the war the Netherlands practically controlled the Dutch East Indian market, and the United States had almost no share in it. But when the war stopped European commerce, America began supplying that market. The result is that we now have a foothold there. Our goods are known and we may reasonably expect to retain a substantial portion of this new trade—not only with Sumatra, but also with the much larger market of Java, with its 30,000,000 inhabitants.

The United States supplied 22 per cent of the imports of steam machinery for workshops on the Sumatra East Coast in 1918, a percentage which was exceeded only by Singapore. But since Singapore is merely a distributing point for American and European products, its large percentage adds to our figures.

Figures on exports from San Francisco to the Dutch East Indies show that the exports for 1918 were more than 100 times greater than during 1914. Exports via the Golden Gate to the Dutch East Indies during the year 1914 totaled in value only $129,118. In 1918 exports totaled $14,657,206. Practically all exports to the East Indies during the war went through San Francisco, and almost all the exports were carried by the steamers of the Java Pacific line.

Japan Purchasing American Machinery

A. L. Osborne, president of the Westinghouse Electric International Co. of New York, recently sailed from San Francisco for the Orient on a 3 mo. tour for the purpose of studying trade conditions in China and Japan.

Mr. Osborne, who also is vice-president of the Westinghouse Electric and Manufacturing Co., said that the Oriental imports of American-made electrical goods have increased in a remarkable degree during the last year. The demand this year for electrical appliances of a general nature promises to exceed greatly the figures attained in 1919, he said. Not only do Japan and China clamor for every kind of electrical machinery, but demand American-made steam turbines and gear drives used in the production of electricity.

A number of extensive power plants are now under construction in Japan, while others are under contemplation and extensions are being made to others.

American and Japanese capital has recently combined to project a huge hydroelectric power plant in Japan for manufacturing aluminum, it was announced recently by J. W. Rickey, hydraulic engineer for an American concern, who arrived in San Francisco from Japan. As a result of Rickey's 3 mo. visit to Japan, the Nihon Suiryoku Kubshiki Kaisha has been organized with a capital of 10,000,000 yen, subscribed by capitalists of both countries.

This is the first attempt made in the Orient to manufacture aluminum. The raw products will be shipped from the United States by way of San Francisco. Mr. Rickey also said that additional plans have been made

for the complete development of Japan's potential power by a combination of American and Japanese capital.

It was recently learned that the Kiso Electrical & Industrial Co., Ltd., is planning the construction of a power plant to supply concerns in the territory surrounding Nogoya. The plant will be a 30,000-hp., hydroelectric development undertaking. It is said that the plant will cost approximately $5,000,000. The present plan calls for its erection on the Kiso River under a water head of 110 ft.

It was recently learned that two 25,000-kw. steam driven turbine units have been ordered for shipment to Japan. When installed, they will complete the largest steam driven electrical installation in the Far East, now being erected at Osaka, Japan, for the Osaka Electric Light Co. This company furnishes light and power to street railways, steel plants, shipyards, copper refining plants, paper mills, electro-chemical installations, etc. These two new units will bring the capacity of this plant up to 100,000 hp.

The Diamond Mountain Electric Railway Co., capitalized at 5,000,000 yen, is expected to construct in Kangwondo Province, Korea, a line about 63 mi. in length and to establish at Diamond Mountain a water power project which will supply power to industrial enterprises along the line of the railway.

An American firm has recently received from the Imperial Steel Works a second order for electrical steel mill equipment. An electric motor for a reversing slabbing mill and a complete set of accessory apparatus are included in the order. The mill is designed to roll ingots from 25 tons in weight to slabs of from 4 by 20 in. to 17 by 46 in.

These instances illustrate Japan's varied and highly promising market for electrical and power plant equipment.

A third extension has been approved by the Inawashiro Hydraulic Co., one of the largest power plants in Japan. The total cost of the extension which includes the construction of the third power house and erection of new transmission lines to Tokyo, will amount to about $12,500,000. The total power obtainable from the extension is 26,000 kw.

It is estimated that the electric power of Japan aggregates about 1,000,000 kw., of which about 750,000 is hydroelectric and the balance steam or oil driven. A Japanese engineer says that Japan is estimated to have water power sufficient for the development of 5,000,000 kw. of electric power, and in view of the country's limited supply of coal and oil every effort is being made for its rapid development to serve railroads and industrial enterprises.

Developments in China

Of all the countries in the Orient, China is universally recognized (by practically every traveler returning to the States from that country) as America's most potential market. Awakened China is starting out on an industrial career. China is planning to build the largest hydroelectric plant in the entire world, according to Jen Chow, a former Cornell man, who arrived recently in this country from the Orient to purchase machinery and supplies for the Chentgu Light and Power Co., as well as to study hydroelectric development in the United States.

"The big hydroelectric plant will be built in the Province of Szechuan, making use of the enormous power, hitherto wasted, of the Yangtse rapids," said Mr. Chow. "A great Chinese Panama in the heart of Asia is our ultimate aim. Our electrical project will be the first step in the gigantic operation of harnessing the water power in the Upper Yangtse, whose potential power is far in excess of that of Niagara Falls.

"The Japanese boycott really has caused a new industrial life to bloom all over China. The Foochow and Tientsin incidents have had a wonderful influence in intensifying the boycott. The Japanese boycott has been one of the greatest things that could have happened to the American market, as it has created a demand for American goods which the American merchant has been slow to realize. An industrial China is the need of the moment, and that, added to the protective tariff system, will make China the giant among the industrial nations of the world."

During the past few months, many Chinese have arrived at San Francisco for the purpose of studying the industrial, electrical lighting, and power systems of the United States.

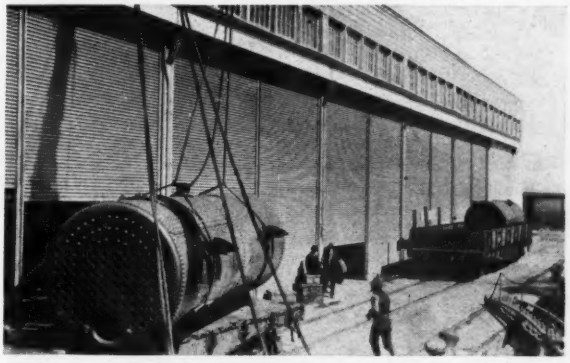


FIG. 5. 72-IN. BY 18-FT. BOILERS EN ROUTE TO HAWAIIAN ISLANDS

Cheng Wen Chih, a representative of the China Industrial Committee, arrived in San Francisco not long ago. His main purpose of visiting the United States was to study at first hand the electrical lighting and power systems of this country. The interior cities and towns of China, according to Chih, are fast adopting modern methods for utility and comfort, following the United States in this respect.

J. Spunt of the firm of Spunt & Co., one of China's leading cotton export and import concerns, with headquarters at Shanghai, and with offices in San Francisco, recently arrived in this city and stated that China offers great possibilities for cotton mills. He said: "At the present there are 40 odd cotton mills in China, and machinery has been ordered for 20 more, a large proportion of this being American machinery. Much more machinery would have been ordered but for the fact that the time for delivery was set as late as 1922, when I left China.

"The profits of the Chinese mills have been fabulous, some of the spinning mills paying dividends exceeding 100 per cent. The goods spun in these mills are sold principally in China and Japan."

Discussing trade in general, Spunt said: "China produces almost everything on earth, and is from this

point of view, at present only in her infancy. Americans are coming out in large numbers, and several American banks have been started there. Prospects for the extension of trade between China and the Pacific Coast of the United States are excellent."

Kang Wu arrived in San Francisco about 20 mo. ago for the purpose of purchasing large quantities of mining machinery. He said the prospects for mining in China never were better than they are today.

All of this development in China will, of course, require power plant equipment and electrical appliances, and these facts should encourage the American manufacturers of such equipment to extend their commercial activities in this country. America's trade opportunity in China lies in the fact that the Chinese know the

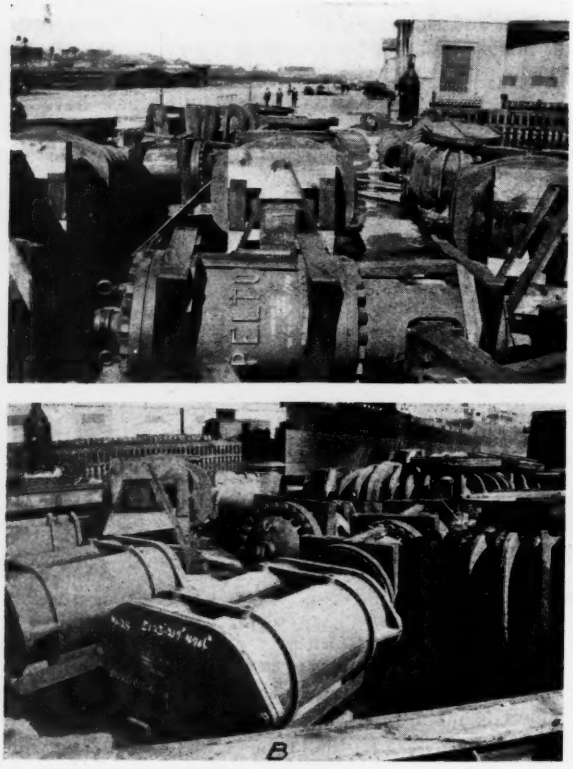


FIG. 6. HYDROELECTRIC POWER EQUIPMENT AWAITING SHIPMENT TO INDIA

United States through its acts in the past. They know what America did in the matter of the Boxer indemnity, and they realize what it has done for the Philippines. They believe in America and want to trade with it.

Chao-Hsin Chu (Consul General of the Republic of China at San Francisco) says that the Chinese market is ready for American-made goods. He says: "It is indeed America's opportunity. The present exchange rate is in favor of the Chinese consumer, as one dollar in Chinese money can buy an article worth one dollar and fifteen cents gold in America. The purchasing power in China has increased over 100 per cent of prewar times.

"In order that successful results may be achieved by America in its Oriental trade, I wish to suggest some plans which would give inspiration to American capitalists, manufacturers and merchants, if they are willing to co-operate with our Chinese people in this respect.

"First: I suggest the formation of an American-Chinese financial syndicate, having the American financiers on the one part and either the Chinese Government or Chinese individual financiers on the other part. The first step to this end would be to send a delegation of such American financiers, together with Chinese representatives to China to investigate the economic situation and the resources of China.

"Second: Let a large mercantile corporation be established for the exchange of products between the two countries.

"Third: Arrange for the erection of factories in China for the use of China's low-wage labor, and for the utilization of the tremendous quantity of raw material available over there. Manufactures so turned out would not alone be used to satisfy the wants of the Chinese consumer, but would also excel in neighboring markets as well.

"Finally, the activities of the syndicate would be extended in other fields, such as banking, mining, railroading, shipping, etc. In short, the economic development of the future China will depend upon such co-operative exploitation, and the government would help by the granting of proper franchises, etc., upon terms of mutual profit."

American Machinery in India

One of the largest hydroelectric power plants ever shipped from San Francisco was recently built by an American company for the Andhra Valley Power Co., near Bombay, India.

The equipment was sent out in three shipments, two shipments going out some months ago, and, the third to go out in a few days.

Two photos herewith show one of the shipments. The equipment was delivered to the bulkhead of the Pacific Mail Co.'s docks, and loaded onto the deck of one of the special barges maintained at San Francisco for such purposes. The barge was then moved along side the Pacific Mail steamer, which delivered it to Calcutta, India. The equipment consists of six units of 15,000 hp. each, making a total of 90,000 hp. The turbines are of the single, overhung impulse type working under a head of 1620 ft. The manufacturers stated that this is the world's largest single, over-hung impulse turbine. The gate valves on each unit weigh 11 tons each, and have an inside diameter of 30 in. In order to show the opportunity that American power plant manufacturers have for obtaining business in the Orient, it may be interesting to know that the manufacturers obtained the contract in open competition with European manufacturers.

An official of the water wheel manufacturing company recently informed the writer that the hydroelectric power of the Orient is about one per cent developed at the present time.

The generators for the India plant are also being furnished by an American company.

British and American capitalists have organized to erect two mammoth steel plants at Bombay and Calcutta, India, which will involve the expenditure of $30,000,000 and will supply the raw products for ship-

building and manufacture of machinery in the Far East, it was announced in San Francisco by E. D. Monroe, engineer for the Tata Iron & Steel Co. Mr. Monroe said that all the coal and iron needed are produced in India and the fuel will consist of gas, which will be produced by plants erected. Coke will thus also be obtained.

It is reported that two first-class jute mills, in one of which American capital is interested, are to be established in Calcutta, British India. These enterprises involve a capital of about $5,000,000 each, and the one is reported to be entirely American, and is to be equipped with American machinery.

Sir Frank Popham Young, for 7 yr. British Commissioner in the Punjab, India, in an address before the San Francisco Foreign Trade Club, on "Commercial Opportunities in India," said:

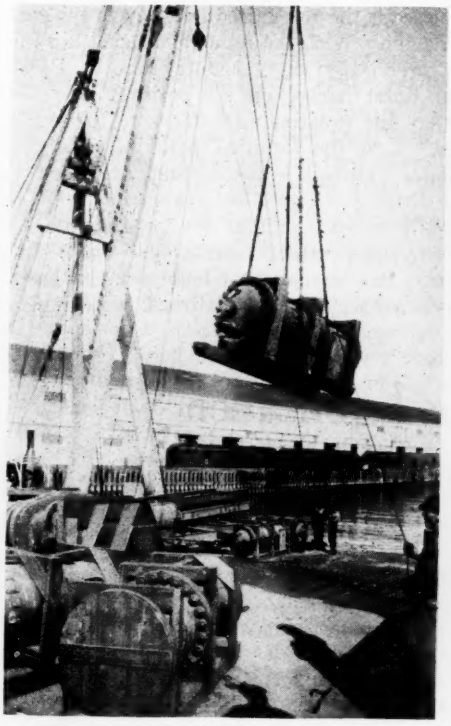
"The ground work for developing Indian industry has already been done. The psychological moment is now, and I as a Britisher urge American business men to go into India because I believe it is much better that the country be developed as fast as possible than that the slower development be carried on solely by British capital.

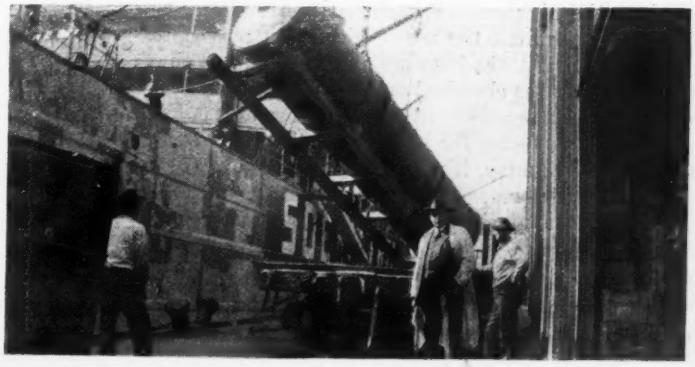
"India is on the threshold of an industrial awakening. Already she is making excellent steel, and when a nation has advanced to the steel-making stage she is well along the road toward industrialism."

Some interesting information on the Kailan Coal Fields of China was given out in San Francisco some time ago by Major W. S. Nathan, C. M. G., "coal king" of the Orient, and head of the Kailan Mining Administration, which exploits a 10-mi. stretch of coal mines near Tientsin, China.

He said: "The Kailan Fields are producing 15,000 tons of coal a day. Most of this is used in China by the many large factories that are springing up everywhere, such as cotton mills and other industries, by the steamship companies, and the railroads. We have also exported our coal to San Francisco, and I believe that we will in the future ship further large quantities of coal to San Francisco. We will be able to do this advantageously, as soon as freights go down. We are also shipping coal to England, and each year we export 1,000,000 tons to Japan.

"We mine our coal at a depth of 1600 ft., and use a great deal of American machinery, besides British machinery."





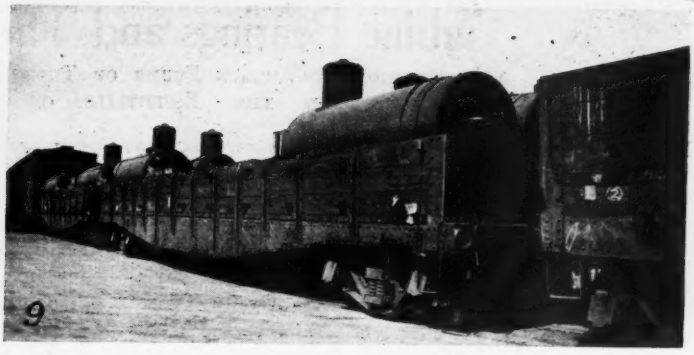


FIG. 7. LOADING PARTS OF HYDROELECTRIC POWER PLANT EQUIPMENT ON BARGE AT SAN FRANCISCO FOR SHIPMENT ON PACIFIC MAIL STEAMER TO INDIA

FIG. 8. OIL REFINING EQUIPMENT BOUND FOR DUTCH EAST INDIES

FIG. 9. EIGHT BOILERS AND ENGINES EN ROUTE TO SIBERIA

Major Nathan predicts that in the near future China will become an important producer of iron and steel, as she has great deposits of these minerals in the Yangtse Valley, which are now being rapidly developed.

The combine of which Major Nathan is the head is financed for one-half by British interests and for the other 50 per cent by Chinese financiers.

Rich Opportunities in South America

According to travelers returning from South American countries, a most promising future for American power plant equipment exists in these countries.

Carlos De Berna, who has spent many years in South America, spoke before the San Francisco Foreign Trade

Club, a few weeks ago, and said that oil interests are to construct near Valparaiso both a complete storage, packing and distributing plant, and a can-making factory to provide containers for petroleum.

A company capitalized at $5,000,000 is to construct near Santiago a central power station of a capacity of 30,000 hp. This plant will serve the factories, old and new, and especially the metallurgical industries, and also the irrigation projects in the republic. Power will be furnished Valparaiso and Rancagua and will make possible the electrification of the Santiago-Valparaiso railway. The electric power will be particularly effective in overcoming the high price of coal and the difficulties of obtaining petroleum.

According to a report made to the Bureau of Foreign and Domestic Commerce a few months ago by Trade Commissioner Philip S. Smith in Argentina and Uruguay, the high cost of imported fuel and the lack of water power limit the use of electricity to some extent; but in Brazil, the immense amount of water power available makes the electrical field a peculiarly attractive one to manufacturers of electrical equipment. As this water power is found for the most part in the coastal section of the country, it will be available for industrial enterprises and for general lighting, heating and power purposes in the numerous cities of this section, which includes the greater part of the population of the country.

American materials were not a very important factor in Argentina before the war, but have become decidedly so since hostilities began, the report says. The problem there is to maintain this advantage when the old competition returns. In Brazil American electrical supplies have always been favored above all others, owing principally to the fact that the power plants in the large cities use American materials almost exclusively. Germany's share in the trade, however, was increasing steadily up to the time the war started, and since that time Japanese materials have appeared on the market, although not in large quantities.

In Colombia, there is a demand for machinery of various kinds for the development of Colombian industries. The river districts where electric power may be obtained offer a valuable market for electrical machinery. The field for the sale of oil engines of moderate power for crushing seeds and nuts for oil and also for milling machines, for the treatment of cocoa beans, sugar, etc., is promising.

San Francisco is the recognized gateway to the countries of the Pacific. With the numerous steamship lines radiating to practically every country on the Pacific, and with the finest harbor on the entire Pacific, San Francisco offers the greatest advantages to the American exporter. It is the terminal point of four great transcontinental railroad systems, that are open the year round. During the past few years, the harbor has been practically rebuilt, and at the present time the great modern piers extend along the water front for about 5 mi. San Francisco undoubtedly now has the most complete harbor belt line railroad switching system in the country.

Turbine Bearings and Their Lubrication

A Description of Various Forms of Turbine Bearings, Methods of Lubrication, and the Essentials of a Good Turbine Oil

IN VIEW of the extremely small clearances between the blading and the casing or the spindle in modern steam turbines, and, considering the high rotational speeds commonly employed, the correct design, construction and lubrication of the journals and bearings for these machines is a most important problem. A variation in the alinement of the bearings of only a very small fraction of an inch, especially in the case of the reaction type of turbine where the radial clearances are measured in thousandths of an inch, will allow the rotor to drop sufficiently to cause a "rub." Therefore, the wear on such bearings, even with journal surface speeds of 50 to 80 ft. per sec. should be practically nothing, if the turbine is to run for any extended period of time. As an illustration, however, of the excellence that can be attained in bearing construction, it may be said here that certain turbines of 5000 to 10,000 kw. capacity have, after being in service for as much as a year at a time, shown no appreciable wear when the bearings were examined. Such performance is only possible when there is an unbroken film of oil between the journal and the bearing, thereby preventing all metal contact, and practically all wear.

Practice, however, varies widely with regard to the construction of bearings. Builders of impulse turbines, almost without exception, use cast-iron bearing shells provided with spherical self-alining pads and lined with white metal. Some manufacturers still retain the original form of bearing devised by Parsons in 1890, for small high-speed machines where the bodies revolve above their critical speeds.

This type of bearing is shown in detail in Fig. 1 and consists of a brass tube, B, with suitable oil grooves cut on the inside which forms the bearing proper, and has a dowel arm, L, which fits into the bearing cover to prevent the bearing from turning. Around this tube

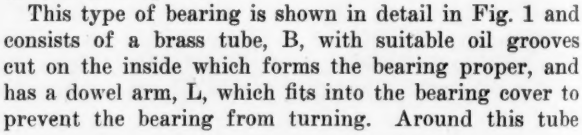


FIG. 1. CONCENTRIC CYLINDER BEARING

are three concentric tubes, C, D, E, each fitted over the other with some clearance so that the bearing itself is free to move slightly in any direction. The nut, F, holds these tubes in place, and this nut in turn is held in place by the small set screw. The bearing with the surrounding tubes is placed inside of a cast-iron shell, which rests in the bearing pedestal on the blocks and liners shown. Leakage of oil past the bearing is prevented by a thin packing ring. Oil enters the chamber at one

end of the bearing and passes through the oil grooves, lubricating the journals and then out into the reservoir under the bearing. The clearance between the tubes is also filled with oil and forms a cushion, the purpose of which is to dampen any slight variation of the spindle and thus to provide a more quietly running machine. The tubes permit the revolving element to tend to revolve about its gravity axis rather than about its geometric axis. The results are the same as were later obtained by Dr. De Laval by means of his flexible shaft.

Experience, however, has shown that the above described bearing with its nest of tubes does not always tend to reduce vibration and therefore, a more quietly running machine. It is often a real source of danger when the added clearance of the spindle due to play between the rings is considered. This construction is also much more expensive than the white metal bearings.

The white metal bearings usually employed in the larger machines are split to permit of their easy removal without disturbing the shaft. When reduction gearing is used the bearings are very often split vertically on account of the load, in this case being mostly in a horizontal direction. They are provided either with ring or forced lubrication, depending upon the size, and with ball seats to allow the bearing to line itself to the shaft.

A bearing of this type for use with forced lubrication is shown in Fig. 2. It consists of two cast-iron shells, A and B, lined with babbit, held together by bolts and supported by the blocks and liners HH. The bearing metal is bored out slightly larger than the shaft, and is further bored along the sides so that the horizontal dimensions of the bore is somewhat greater than the vertical. This gives close contact only along about two-thirds of the lower half of the circumference, and allows ample space for the oil to produce perfect lubrication. Oil is forced in at the point D, and passes around the passages E, entering the bearing at F.

The outer shell is provided with four recesses in which are fitted keys, as shown at H, upon which the bearing is carried in the pedestal. By means of a number of sheet metal liners behind these keys, accurate adjustment of the bearings may be made so as to give any desired adjustment to the rotating element with reference to the stationary part. The position of the rotor may thus easily be determined as well as a definite knowledge of the least radial clearance obtained.

In types of bearings not employing the use of liners, the exterior of the shell is ground on all contact surfaces. The bearing brackets are also scraped to standard lining bars to insure alinement of the shaft and perfect interchangeability of the bearing shells.

The practice of cutting oil grooves in the bearing metal is rapidly diminishing in the construction of turbine bearings and a great many are built without oil grooves. Particularly in the lower half of the bearing where the greatest pressure exists, the tendency of the oil grooves is to break down the film of oil between the journal and the bearing, thus allowing the metal surface to come in contact. An oil groove is sometimes cut parallel of the axis of the bearing in the upper half of the bearing for the purpose of distributing the oil towards the ends.

Thrust Bearings

Thrust bearings are provided on practically all types of turbines. They serve to adjust the position of the rotor and to take up any end thrust that may be present. The usual form of thrust bearing consists of a number of brass collars fixed in the two halves of the shell which fit into grooves cut in the shaft. These collars are adjustable and permit the position of the shaft to be accurately fixed.

In many of the larger sizes of turbines, the well-known Kingsbury thrust bearing is used. This is a form of self adjusting bearing admirably adapted for taking up end thrusts, due to its high efficiency and the small space which it occupies per pound of thrust. The thrust which this form of bearing is able to take care of sometimes runs as high as 5000 lb. per sq. in. although in most turbines it rarely reaches 500 lb. This bearing consists of six prineipal parts, or sets of parts, enumerated as follows: the casing, the floating ring seats, the floating rings, the shaft collar, the self-alining thrust blocks, and the oil clearance ring. There are three or more segments on each side of the shaft collar which is mounted on the turbine shaft. These segments or thrust blocks, are made of machine steel faced with bearing metal and provided on the side opposite the face with a high grade tool steel, hardened pin on which

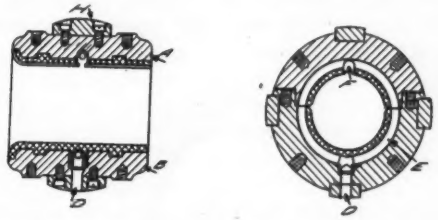


FIG. 2. SELF ALINING WHITE METAL BEARING

the segment rocks in order to equalize the thrust of the collar. These pins allow the segments always to bear directly against the shaft collar and tend to avoid any unequal distribution in the amount of thrust. When in operation, the whole bearing is under an oil pressure of from 6 to 15 lb. and the high speed of the turbine tends to keep a film of oil between the collar and the segments at all times. This is absolutely essential to the proper operation of the bearing. Under average working conditions, the oil clearance on the Kingsbury thrust varies from 0.006 to 0.012 in. dependent upon the speed of the turbine.

Lubrication

Proper lubrication is effected when a thin film of oil lies between the journal and the bearing in such a way that there is no metallic contact. Then there is no appreciable wear. Wear and friction are so closely related that they are usually considered to be nearly synonymous terms, but experiments at low pressures show that the friction is less for dry surfaces than for a bearing flooded with oil, but it is certain that the wear must be greater. The friction of a lubricated bearing is due to the shearing of the lubricant which, while producing heat, does not damage the bearing. Within reasonable limits, a hot bearing is more efficient than a

cool one, as the thinning of the lubricant reduces friction.

High temperature is normal for a properly lubricated, high-speed turbine bearing, but the viscosity of the oil must remain sufficiently high to keep the rubbing surfaces apart. Since the viscosity of a lubricant decreases with an increase in temperature, the bearing pressure for a given speed must not be exceeded beyond certain limits, as the resulting increase in temperature due to friction will further reduce the viscosity until the oil film breaks down.

In a steam turbine, however, the bearing temperature is due not alone to the shearing of the oil, but is due partly to the heat of the steam which is transmitted through the shaft. Consequently, the normal temperature may be somewhat higher than expected.

In Europe many turbines are run with a minimum amount of oil and with oil leaving the bearings at temperatures as high as 190 deg. F. This practice is based on the argument that such a system requires the least expenditure of power for oil circulation and in friction losses. Practice, however, seems to be tending towards flooded lubrication. In this system, a large quantity of oil at a temperature of about 90 to 100 deg. F. is forced through the bearing by means of some form of pump, driven from the turbine shaft. The oil pressure at the bearings varies from 3 to 20 lb. per sq. in. With this system, the life of the oil is much longer than in systems using the very hot oil, and any wear on the bearing is absolutely prevented.

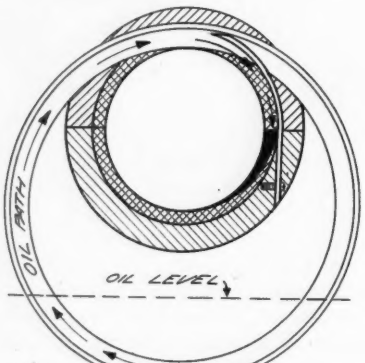


FIG. 3. CHANNEL OIL SCOOP DEVICE

According to A. C. Christie the best results with this system are usually obtained when the temperature is about 125 deg. F. To control the temperature, a number of turbine bearings are constructed so that cold water may be circulated around them. This cannot be recommended in all cases, especially where the water is dirty or where it contains scale-forming impurities. It is, in most cases, more satisfactory to use the cooling water on the outside of small pipes in a properly designed cooler. Scale can more readily be removed from an oil cooler than from the interior of a bearing shell.

Manufacturers have been able to cut down the length of the bearing with the flooded system of lubrication and thus reduce the total length of the turbines. No difficulties have been introduced with the increased pressures per unit area and pressures of 80 to 100 lb. per sq. in. at surface speeds of 50 to 60 ft. per sec. are common practice.

In small machines where the rotors are comparatively light, ring oiling is satisfactory. This system is too well known to require any detailed description. It consists, essentially, in hanging a ring or chain on the journal so that when it rotates the ring will turn with it. These rings usually dip into a reservoir underneath the bearing and carry the oil which adheres to them to the upper surface of the journal. The rings are made in various forms and their effectiveness is sometimes augmented by the addition of oil collecting devices to guide the oil to the moving surfaces.

A device of this kind, called a channel oil scoop, is shown in the accompanying sketch, Fig. 3. Oil is taken from the reservoir by the rapidly revolving oil ring and is held in the ring by centrifugal force until it is diverted to the bearings by means of the scoop at the side. This device insures positive lubrication without the use of a pump. The scoop actually forces the oil to the bottom of the bearing where the greatest pressure and need of lubrication exists.

In one form of bearing for small high-speed turbines, lubrication is effected by means of a spiral groove cut in the spindle. At one end of this spindle is an oil ring which carries the oil from the reservoir to the end of the groove, and, as the spindle revolves, the oil is forced under pressure over the entire bearing surface, the excess returning to the oil reservoir at the inner and outer ends of the bearing.

Turbine Lubricating Oils

THE PRIME consideration in the selection of a lubricating oil for turbine work is its suitability for the purpose. Since the consumption of oil in a turbine is small, the loss being due only to leakage and a small amount of evaporation and wear, the price paid for the oil should be a secondary consideration. The following discussion on the specifications for a good turbine oil were prepared for us by Edward T. Blaker of the Vacuum Oil Co.

An oil is rated, sometimes, by physical characteristics, i.e., gravity, pour, flash, fire, viscosity and color.

These characteristics have little or no bearing on a turbine oil. A turbine in operation keeps the oil warm and consequently pour test is eliminated, as turbines are rarely exposed to the elements. The temperature of oil in a turbine never approaches the flash or fire point, so these characteristics are eliminated. Color test is used to keep the oil uniform at the refinery and can be called one of the tests of standardization.

Gravity and viscosity are also better tests of standardization of manufacture than an indication of the service value of an oil.

Let us forget physical characteristics for the moment.

As we think of an oil for the lubrication of a steam turbine, we must first picture in our mind how this oil is applied. On turbines of any importance, oil is applied by means of a circulating system. There are two general types of circulating systems—

(A) Pressure circulating systems,

(B) Gravity circulating systems.

In a pressure circulating system, the oil is applied to the bearings by pressure direct to the journal. This pressure may be either by pump or an overhead gravity tank giving a head to the oil.

In a gravity circulating system there is no pressure

of oil direct to the bearings. The pressure is broken by a sight feed glass which allows the oil merely to drip on to the bearings in small drops. The oil may be applied to the sight feed glass either by a pump pressure direct, or by a tank above the bearings allowing some pressure by gravity, but there is no pressure of oil to the bearings.

Now that we have considered the method by which the oil is applied to the bearings, it is well to see what factors are present which affect the oil. These factors will determine the characteristics of an oil which should be used in a circulating system.

You may have two oils of the same physical characteristics, i.e., the same gravity, viscosity, flash, fire, etc., and though these oils are similar in physical characteristics, one of them will be a successful turbine oil and the other will be a failure. This fact, therefore, eliminates physical characteristics and leaves us with the necessity of selecting a turbine oil which is refined to meet the operating conditions found in a turbine.

We have to meet the following in a circulating system of a turbine:

1. Water.
2. Solid impurities.
3. Temperature.
4. Rapid circulation.

Water causes emulsification. This immediately eliminates any possibility of using a compounded oil. It also makes it necessary for a turbine oil to possess the characteristic of rapid separation from water. A good turbine oil should be able to meet the most severe emulsification tests. Emulsification causes thickening, clogging of pipes and strainers and screens and unless watched very carefully will result in the stoppage of oil supply to the bearings and finally in a serious breakdown.

Solid impurities which might collect in the system from dirty conditions of the surrounding atmosphere, the carelessness of operators, or dirt left in the system when manufactured will cause the clogging of screens and pipes and many times result in the stoppage of oil supply to the bearings. In order to cope with this difficulty, therefore, the turbine oil should have the characteristic of rapid separation from all solid impurities. It should be able to throw them down quickly, while the oil is resting for a short period in the sump tank.

Temperature is a big factor and has created a great deal of controversy. Temperature is transmitted along the journal and it is necessary for the oil, coming into contact with this journal, to carry away some of the heat from the bearings. This heat must then be dissipated from the oil by means of cooling coils, or allowing the oil to stay idle in a large tank. Very often turbines are not furnished with large tanks for the dissipation of heat and cooling coils are used for this purpose. Sometimes a combination of both is found. The oil must have the ability, however, to take up heat rapidly and dissipate it rapidly. This results in lower temperatures in the oiling system, means less vaporization and consequently lower oil consumption.

An oil too heavy in body in this condition will cause foaming and will result in excessive consumption. An oil too light in body will vaporize excessively, leaving the heavier parts of the oil in the system and will make it necessary to add large amounts of oil to replenish the system and keep the oil of the proper body. Gradually, however, the oil will get heavier, despite the make-up oil added and foaming will again result. This means increased temperatures and the danger of burnt-out bearings and shut-downs.

Rapid circulation has the tendency to break down an oil and also is a strong agent in mixing impurities with the oil and keeping them there. An oil must be very tenacious and tough to withstand rapid circulation and the amount of wear which is required of it. It passes through frictional surfaces several times in an hour and must be of very high quality to withstand the exceptional wear required of it.

To sum this matter up, a good turbine oil should possess the following characteristics:

1. Rapid separation from water and other impurities.
2. Easily filtered.
3. Should radiate heat from the bearings.
4. Should not corrode the journals or bearings.
5. Should not break down under continuous service.
6. Should require very little make-up oil in the system.

If an oil will meet all of these requirements satisfactorily in service under operating conditions generally found in practice, it is a good turbine oil and needs no further specifications. It is well to remember, again, that the physical characteristics do not make an oil, but it is the things that the oil will do under service that make a good turbine oil.

Do not consider an oil from the point of physical characteristics, but rather from its service value. Ask the builder of the turbine, who knows his equipment best, for his recommendation, as he has spent large sums of money in investigating lubricants for his equipment, in the field and factory, and will protect you by suggesting a lubricant which will allow his equipment to serve you to the best advantage and highest efficiency.

Stack Weighing 990 Tons Built at Syracuse

THE TALLEST chimney in central New York has just been finished by a New York concern for the H. H. Franklin Manufacturing Co., at Syracuse, N. Y., as part of a new heating and power plant. It is 250 ft. high, 20 ft., 6 in. outside diameter at the base, and 11 ft. 3 in. outside diameter at the top. The wall is 7½ in. thick at the top.

The chimney weighs 990 tons above its foundation and in its construction 14 carloads of brick and one carload each of cement and lime were used. It is built to stand a wind velocity of 100 mi. per hour and internal heat up to 800 deg. F. Its extreme height will mitigate the smoke nuisance and deposits of soot.

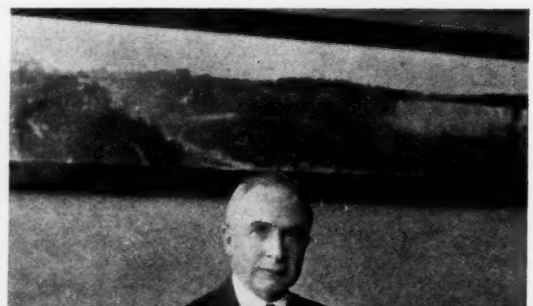
S. J. Borden, of Pittsburgh, was the foreman in charge of the job, which was completed in 28½ working days under a contract which allowed 40 days.

WHAT IS thought to be a world's record for continuous running of machines of its class was reached by a 45,000-kw. Westinghouse turbo-generator recently shut down at the plant of the Narragansett Electric Lighting Co., Providence, R. I., after steady operation for 84½ days.—Steam.

CALVERT TOWNLEY

HE SUPERVISED THE ELECTRIFICATION OF IMPORTANT RAILWAYS AND THE BUILDING OF A TOWN FOR ELECTRICAL WORKERS. NOW PRESIDENT OF THE A. I. E. E.

PLUMED WITH the exhaust from scores of stacks, stretching its buildings over miles of land, a huge electrical manufacturing industry at Pittsburgh has special pride in the achievements of its popular vice-president, Calvert Townley. Known internationally as an authority on railway electrification, Mr. Townley is numbered among America's leading engineers.



Calvert Townley

He was born in Cincinnati, O., Oct. 18, 1864. His father, John A. Townley, came from an old English family of which Col. Richard Townley crossed to this country in 1683 in the suite of Lord Effingham Howard, Governor of Virginia. His mother was Carrie A. Calvert, a descendant of Cecil Calvert, Lord Baltimore, who founded the city of Baltimore.

After spending his boyhood days in Cincinnati, young Townley was graduated in 1883 from Chickering Institute, being valedictorian of his class and was 3-yr. gold medalist in mathematics. He entered Sheffield Scientific School, of Yale University, and was graduated with honors from the mechanical engineering course in 1886. Continuing his studies after graduation, he received the degree of M. E. in 1888.

In the fall of 1887 after a brief term with the Brush Electric Light Co. of Cincinnati, Mr. Townley joined the Westinghouse forces as a road engineer, but was transferred soon afterward to the sales department as one of its seven men covering the entire United States. Thereafter for 17 yr. Mr. Townley continued with the Westinghouse Co. In 1889, he developed the Cincinnati territory, going thence to Pittsburgh as executive assistant to the vice-president, and in 1895 he was made manager of the Boston office. In 1900, he became general agent with headquarters in New York, being given a free hand to establish relations with the several large corporations who were then beginning extensive electrical expansion.

At the end of 1904, Mr. Townley resigned from the Westinghouse Co. and became acting fourth vice-president of the New York, New Haven & Hartford Railroad, in charge of the proposed electrification of its lines out of New York. When the New Haven Road began acquiring trolley lines, he was appointed the ranking vice-president of the subsidiary company created to operate these lines and took general executive charge of them, continuing, however, as a consultant for the parent company on electrification.

In 1911, Mr. Townley returned to his early allegiance, this time as assistant to the president in New York, and became concerned with a wide range of unrelated corporate activities which the rapid growth of the company had made it difficult to departmentalize. Among other duties, he served as president of the Lackawanna & Wyoming Valley Railroad and vice-president of the Niagara, Lockport & Ontario Power Co. until the Westinghouse holdings in those properties were sold. He represents the company on the directorates of various corporations.

In 1913, Mr. Townley toured Europe and in 1914-15 circled the South American continent in the Westinghouse interest. He was later identified with the construction of the new factory development at South Philadelphia and in 1918 supervised the building of a town at that place for the workmen. Back in 1909, he had joined in organizing the Kolynos Co., a corporation formed to manufacture tooth paste and kindred products at New Haven, Conn., and he has been the president of that corporation ever since.

Calvert Townley joined the American Institute of Electrical Engineers in 1901 and has continued active in its affairs. He has been chairman or a member of many committees; served on the board of directors from 1905 to 1910, first as manager and then as vice-president, and in 1919 was elected president of that body. He has been a member of Engineering Council since its creation.

Mr. Townley has always been an ardent advocate of

exercise and recreation as an essential adjunct to continued and effective brain work. As a youngster, he played baseball and was one of the first high wheel bicyclers. At college, he participated in a variety of sports and held the wrestling honors in his weight for 2 yr. At Pittsburgh, he played football for 3 yr. on the A. A. A., Pittsburgh's first team, and was president of the Pittsburgh Tennis Club. While living at Boston, New York and New Haven he went in for canoeing, horseback riding, sailing, bowling and golf.

After a college romance, Mr. Townley was happily married in 1889 to Edith Wadsworth Case of Hartford, Conn. She died in 1904, being survived by two sons, Clifford Calvert and Donald Case Townley.

Automatic Control of Combustion*

THE CONTROL OF AIR SUPPLY TO ASHPIT BY VARIATION IN PRESSURE OF GASES ABOVE THE GRATES. BY C. G. GRAY

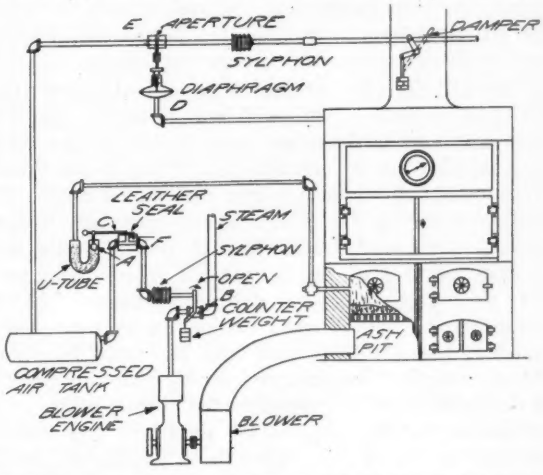
THE AVERAGE steam engineer is in control of conditions from the coal bin to the other end of the factory. He is responsible for the power delivered and in delivering that power he is responsible for the money spent. It is necessary that he be an expert along a great many lines. He must be able to use coal economically to get results. He must look out for steam, electricity, friction in line shafting, motor drives and innumerable other things. He becomes specialized along many lines, not in the sense of the word technical specialist, but a practical specialist.

I expect nearly everybody knows something about combustion. We were taught the rudiments of combustion to a certain extent in school. Nobody had a school primer without the story of the candle flame, but we didn't give it much thought. Now the time has come when we must give thought to it. The life of the country today depends on our conserving what we have and getting the most out of it. Heat units have gone to waste for many years, and the time has come when we must apply ourselves to the saving of them, because there is a limit to what we have for use in the future.

In combustion proper, in furnaces for steam boilers, which is the subject I will dwell on, I may say that the proper place to start a practical talk would be at the old damper regulator which we still find holding forth in a large percentage of plants. It has served its day and purpose. It did well when we had nothing else, and I may say it does well at the present time, but will its control of fluctuating steam pressure ever help combustion? Why have we done nothing for the coal?

Let us take an ordinary fire today in a boiler furnace, stoker or hand fired, using coal or oil or anything else that is combustible. Let us open the door and look in. If the fire could speak, it would say, "I want more air; I am choking for the want of air," or "I want less air; you are flooding me with it." How are we going to accomplish the regulation of that air supply? There are a great many stages that enter into the proper mixing of air with fuel, but at the best, with the ordinary solid fuels we use today, coal for instance, which we will deal with altogether for the present, we find it is very difficult to mix properly with air to obtain anywhere near to a condition of perfect combustion. We have our CO_2 recorders, which help to a great extent, and we have our draft gages, which have been developed in later years to where we can work to 0.01 in. They have helped us a great deal, but the human element still enters into too many cases. If the draft gage shows a certain condition at a certain time, we may find 5 min. later that it has changed. We immediately bring the human element in and change dampers, etc., to what we again consider a stabilized condition. We must realize the importance of this. Why do we not change dampers or blast gates or fan speeds to produce a stabilized condition, automatically?

The points that enter into automatic control of combustion are quite varied. Take for instance a hand fired boiler. The fire has been cleaned and is, we will say, for example, a soft coal fire, a fine bed of glowing coal, about 6 in. thick, in first class condition. The ashpit doors are wide open and remain that way all the time. The damper is wide open, and the steam rises and falls as the load fluctuates. One-half hour after that fire has



METHOD OF AUTOMATICALLY CONTROLLING COMBUSTION BY THE GRAY SYSTEM

been cleaned, it is not in the same condition. We have thrown fuel on the fire in that interval perhaps several times. We have burned the fuel originally on it to ash, covered that with fresh fuel, made more ash, and created a condition of friction through that bed of ash and fuel which is much greater than when we started.

Throughout the whole life of the fire, this goes on. Now, if the condition of the supply of air to that bed of fuel was correct when that fire was cleaned, with any known draft over the fire, whatever it might be, how is it possible for that condition to remain a constant? The same suction continues over the fire, the same openings at damper and ashpit doors are there, but there is an entirely different condition existing in the fire itself. That can be remedied, you will tell me. We will simply

* Abstract of paper presented at a meeting of the American Association of Engineers.

open the damper wider and increase the draft. This increases the velocity of the gases over the fire to overcome the added friction due to its greater depth. Another condition might be starting with the ashpit doors partly closed and opening them from time to time when the fire thickens. Now what have you done? If there is a crack in your boiler walls, you have started an infiltration that will reduce the temperature.

Now suppose you take a stoker fired condition, a chain grate stoker for instance. We will say we are feeding coal 6 in. thick, burning that coal at a certain rate on the grates, which are traveling at a certain rate of speed. You find your steam drops. With a variable load, a rising and falling of pressure is taking place. In some instances, you speed up your grate. Your dampers are open, and your ashpit opening is not variable, it is a fixed quantity. You are burning so many pounds of coal per square foot of grate per hour and you suddenly increase the speed of the grate to generate a greater volume of steam. How can you do this economically? How is it possible? Suppose the condition was correct when you started in. You have now increased the speed of the grates, and taken the coal to the back end and dumped it over without having changed the supply of air furnished in a given time. You must be throwing some of this coal away. With any kind of fuel, that condition will exist. We can try to regulate this condition by hand with dampers, opening of blast gates, etc. The real remedy is to feed the air automatically to the fuel as the rate of combustion changes due to the demand for steam.

We will take for instance a hand fired boiler under the same conditions. We will start in with a fire 6 in. thick and will feed the air mechanically to the ashpit at a pressure above atmosphere. When I say "above atmosphere," don't confuse that with forced draft. The feeding of the air for combustion mechanically under a grate is not forced draft. Now if we find at the start of that fire that we are carrying a safe percentage of CO_2, then we have got our desired condition. The real condition that would make combustion as nearly automatic as possible from that time on would be a variable air supply. Suppose we have ½ in. ashpit pressure at that time, how is it possible that inside of ½ hr., if we look at the same gage, it will show 1 in. and continue perhaps to 1½ or 2 in. throughout the life of the fire automatically?

In all my experiments, I have found only one condition that would come anywhere near realizing this result, and that is to utilize the pressure of gases above the fire to control the air pressure below the fire. In the process of combustion as you all know, you have a combination of oxygen with carbon. For every pound of coal with air fed correctly we have a certain volume of gas. If that volume of gas decreases with the damper open to a certain position, the result will be a draft over the fire or in other words, the partial vacuum over the fire will increase. This vacuum we must use to stabilize the air supply and is what I have found to be the better plan.

Suppose we take an individual boiler fan, for instance, on an individual boiler, and use that fan to put air into the ashpit. We will assume the fan is connected to some means that we may have for the control of its speed by the pressure of the gases over the fire.

The moment that the air has difficulty in getting through the fuel bed to get the proper amount for combustion, the volume of the gases due to combustion will be reduced, because sufficient air has not got through to keep up this volume. When this condition occurs, an increased vacuum exists over the bed of fuel. This vacuum in turn operates the means which increases and decreases the supply or pressure of the air being fed through the bed of fuel, so that the pressure of gases of combustion over the fire will return to the point of original adjustment. Now, by handling the quantity of air supplied for combustion from the variation of the pressure of the gases over the fire, you will see that a definite relation is then established between the volume and pressure of gases over the fire and pressure and quantity of air delivered in the ashpit for combustion purposes, regardless of friction set up due to various thicknesses of ash or coal on the grates.

You will see from the foregoing that by using the pressure of gases over the fire to control the volume and pressure of air delivered under the grates, it is possible to burn efficiently any given quantity of coal per square foot of grate per hour, regardless of the increasing friction set up by the accumulation of ash on the grates through the whole period of the life of the fire.

With stoker fired furnaces, we have just the same condition facing us. If you increase the fuel supply to the stoker, you will be in practically the same position as adding to the thickness of the fire supplied by hand.

With all types of stokers automatically controlled, the best combustion conditions will exist. The fires are not the same at all times throughout the day's run. We may find one boiler with a 2-in. ashpit pressure and the next boiler with a 1-in. ashpit pressure with every draft gage over fire showing the same pressure, which shows conclusively that no two fires under the same treatment will react the same, and that they must be dealt with individually.

The methods for doing this have been many. Water motors have been used, to move dampers and blast gates, but I have found compressed air to be the better medium. Compressed air to begin with, is inexpensive, is clean and can be used at quite high pressure if necessary. The next question is, how are we going to use compressed air and abandon valves? By using apertures. If we take the apertures at different small areas, closing these apertures without valves will give us a tight job. Suppose we take an aperture of 1/32 in. with a weight of, say, 6 or 7 oz. at the end of a lever 6 in. long, and no valve, but simply a piece of patent leather or lead, for a seal, we can hold air against 20 to 30 lb. pressure without the slightest sign of leakage. The least movement of the lead or leather, from the aperture will allow air to escape. The moment the air escapes the pressure in the system is reduced and the damper or blast gate takes a corresponding movement. The movement is positive because there is no opening or shutting of a valve affecting the movement of the piston or diaphragm that may be operating the damper, so in this way we can get stability from that time on from every movement of all parts of the apparatus.

Now suppose we eliminate pistons with the friction attached thereto, and use a flexible diaphragm which will rise and fall as the pressure increases or diminishes.

The action will be positive. We have found that by this method it is possible to keep a constant combustion condition throughout the life of any fire and regardless of the load the boiler is carrying with practically perfect operation.

We go into power plants and find them in fine shape, CO_2 recorders, damper regulators, steam pressure recording gages, etc.; but if we look at the chart on our over fire draft gage, if there are any in the plant, we find it has been going up and down continuously through the day's run. This is what we must eliminate and if we keep a constant draft over the fire continuously we shall eliminate it.

In different cases, we are compelled to use different treatments. The average boiler condition today, however, is most successfully dealt with by operating the damper in the individual uptake of the boiler by the steam pressure in the boiler. If the air is being supplied mechanically, the speed of the fan or the opening of the blast gate, is controlled from the steam pressure in the boiler in synchronism with the damper.

The apparatus used for controlling combustion in this manner is shown diagrammatically in the accompanying illustration. Suppose, due to a thickening of the fuel bed, the pressure of the gases above the grate decreases. This variation in pressure is transmitted to the U-tube, causing the liquid in the left leg to rise. As a consequence, the float A drops, and closes the aperture F by means of the leather disc attached to the lever C. The compressed air thus, instead of escaping through the aperture, flows into the sylphon, causing it to expand. This opens the valve B, allowing more steam to pass to the blower engine, and increases the speed of the blower until enough air passes through the grates to bring about a stable condition.

The damper regulator, although entirely independent from the apparatus just described, works in synchronism with the blower regulator. If the steam pressure rises, the diaphragm D rises, closing the aperture E. This causes the pressure in the sylphon to increase, and the consequent expansion of the sylphon closes the damper.

You can see by operating in this way that you can take care of a fire of any thickness, a fire of any kind you can think of, soft coal, hard coal, oil, or pulverized coal.

U. S. Civil Service Commission announces examinations July 20, for Senior Engineer, Grade 2, civil, electrical, mechanical, signal, structural, telegraph and telephone to fill vacancies in the Interstate Commerce Commission, under the act providing for the valuation of the property of common carriers, at $1920 and $2700, and in positions requiring similar qualifications at these or higher or lower entrance salaries. Appointees at $2500 or less whose services are satisfactory may be allowed the temporary increase granted by Congress of $20 a month. Competitors will be rated on general and technical education, and preliminary or apprenticeship training, responsible experience and fitness. Applicants must have reached their twenty-fifth but not their fiftieth birthday on the date of the examinations. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 1312.

Coal vs. Oil Performance Chart

A Rapid Means of Determining the Amount of Saving When Changing From Coal to Oil or Vice Versa. By L. C. Lichty

ONE OF the first questions asked when it is suggested that a change in fuel be made from coal to oil or vice versa in a power plant, is whether it pays to make the change, and whether the cost of evaporation will go up or down. Calculations are usually made to determine the relation or relative value of the fuels in question, making use of the cost per ton of coal delivered at the plant, its heating value and the efficiency of the boiler plant when burning coal in the one case, in comparison with the results determined by making use of the density of the oil fuel, the heating value per barrel, the cost per barrel delivered and the efficiency when burning fuel.

Everything except the efficiency when burning either one or the other fuel is known. In burning coal, the efficiency obtained is known while it is problematical just what the efficiency will be when changed to oil burning. With large boilers, properly equipped with

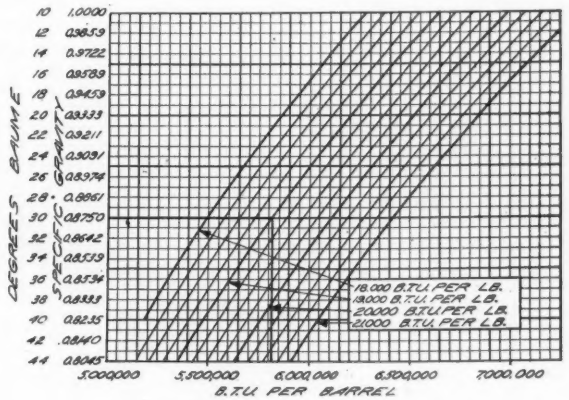


FIG. 1. DENSITY-HEAT CHART

well designed furnaces and burners, it is possible to obtain an efficiency of 82 per cent. This, of course, will not ordinarily be obtained under actual operating conditions, but during test conditions when the operation is very carefully watched. Poor furnace conditions and operation will reduce the efficiency of an oil burning plant lower than if coal were used. So it can be said that under favorable conditions a higher efficiency can be obtained when burning oil than coal, but it is unlikely in average plant operation that the efficiency when burning oil will be greater than while burning coal.

The matter of efficiency, however, is one for each plant operator to decide for himself, as he is the one who knows what conditions are in his plant, and consequently can best say what efficiency may be expected. In making use of the accompanying chart it is left to the operator himself to decide what efficiency he will get when changing from one fuel to the other.

To make use of the chart, first determine the B.t.u. per barrel of the oil in question from the density-heat content chart. Then referring to the coal vs. oil chart, start at the cost per ton of coal and follow a horizontal line until an intersection is made with the B.t.u. per lb. of coal; then follow a vertical line until intersecting the line representing the efficiency when burning coal;

from this point, proceed to the left and the cost of evaporating 1000 lb. of water from and at 212 deg. will be found. Proceed still farther to the left until intersecting the line representing the efficiency when burning oil; then follow a vertical line up until the curve representing the B.t.u. per barrel is reached; then follow a horizontal line to the right to the vertical line through the middle of the chart and the cost per barrel of oil will be found which equals the cost of the performance using coal.

If the cost of oil is less than determined by the chart in the above manner it will pay to change to oil (not considering anything but cost of fuel).

If burning oil, tracing lines around the chart in the opposite manner starting with the cost per barrel of fuel and ending with the cost per ton of coal, will show what priced coal is equivalent to the oil being used.

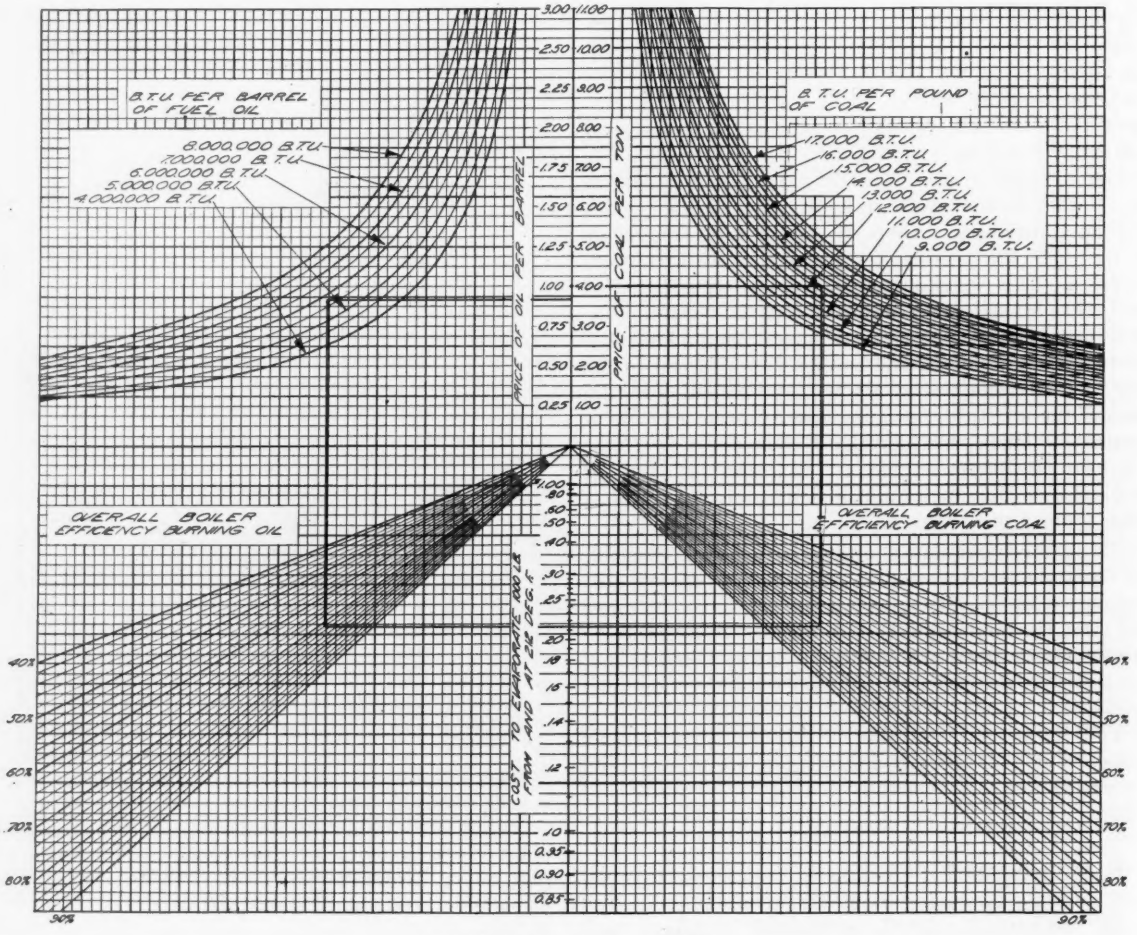


FIG. 2. COAL VS. OIL CHART

AN AGED darkey peered into the boiler room at the power plant house. Seeing one of his younger pals working therein, he exclaimed: "Well! Well! Scipio, what am you doin' hyar?"

"Oh, I'se tendin' dis 30 hoss power biler."

"Thirty hosses?"

"Ehu huh."

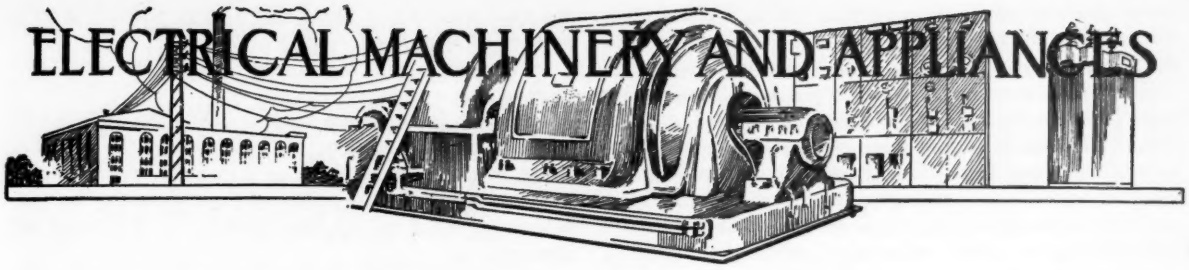
"Say, nigger! How you'se gits dat way? You'se couldn't gits thirty Shetland ponies in dat space."

A Peculiar Fatal Accident

AN UNUSUAL accident to a boiler cleaner which resulted in his death is reported in National Safety News.

After the boiler in question had been shut down for eight days, a workman was sent into the combustion chamber to clean it out. He had almost completed his work when, it is thought, he undermined the bank of fine flue dust so that it fell or slid, throwing up a cloud of hot particles. This hot dust went up the workman's sleeves and trouser legs, causing such severe burns that the man died a few days later. The situation was made worse by the fact that the cleaner was forced to crawl out of the fire box through the hot dust. Investigation showed that the dust while not hot enough to ignite or scorch the clothing, contained sufficient heat to cause the fatal burns.

Experience has shown that while a hose stream may be used for wetting down the cinders, the stream will not penetrate the flue dust and therefore cannot be depended upon to cool the dust. When a workman enters the fire box of a boiler where there is a possibility of the flue dust still being hot, he should wear either union overalls tied at wrist and ankles with burlap over his shoes, or a regulation boiler inspector's uniform.



A Study of Dynamo Electric Machinery---XVI

MOTOR EFFICIENCY CALCULATIONS; CONTROL AND PROTECTIVE DEVICES. BY OTTOMAR H. HENSCHEL

AS IN the case of any machine used for the conversion of energy from one form to another, the efficiency of an electric motor may be defined as the ratio of the output to the input. Expressed as a formula this is:

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

although, as the output is equal to the input minus losses, we may also express the efficiency by means of the following form:

$$\text{Efficiency} = \frac{\text{Input} - \text{Losses}}{\text{Input}}$$

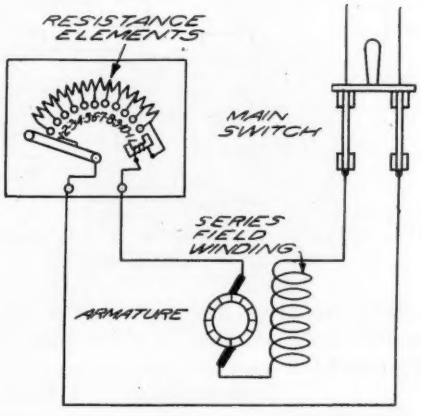


FIG. 113. STARTING BOX CONNECTIONS FOR A SERIES WOUND MOTOR

Taking into consideration only the armature losses and neglecting those due to hysteresis, eddy currents, friction, windage and those due to the resistance of the field coil windings, we may readily deduce a formula expressive of the theoretical efficiency of the motor. Letting E represent the voltage applied to the machine terminals, and Ia the value of the armature current, it is evident that the input is equal to the product of these two factors or EIa. The losses are only those existing in the armature and are equal to $RaIa^2$ where Ra is the resistance of the armature windings. Therefore, as

$$\text{Efficiency} = \frac{\text{Input} - \text{Losses}}{\text{Input}}$$

we have

$$\text{Efficiency} = \frac{EIa - RaIa^2}{EIa}$$

which upon cancellation of Ia becomes

$$\text{Efficiency} = \frac{E - RaIa}{E}$$

In considering the operation of the direct-current motor, we have found a difference to exist between the applied and the counter electromotive force values, and as this difference may be expressed as a drop in voltage we have $RaIa = E - E'$, or by transposition $Ia =$

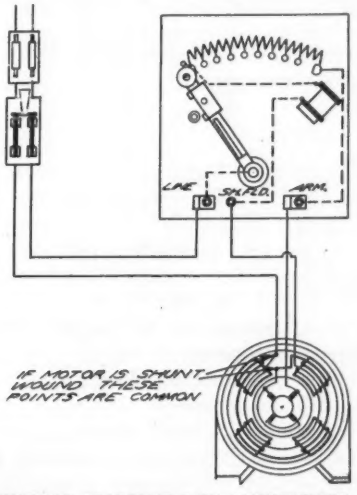


FIG. 114. TYPICAL STARTING BOX CONNECTION APPLICABLE TO BOTH SHUNT AND COMPOUND MOTORS

$(E - E') \div Ra$. If, therefore, this value of Ia be substituted in the foregoing efficiency formula, this then becomes

$$\text{Efficiency} = \frac{E - Ra\left(\frac{E - E'}{Ra}\right)}{E}$$

$$= E' - E$$

Thus approximately the efficiency of a direct-current electric motor may be expressed as the ratio between the counter and the applied electromotive forces.

From a practical standpoint, however, and in order to arrive at a more accurate conclusion, account must be

taken of all of the losses occurring within the machine. Some of these can be measured and others can not, and as a consequence, only satisfactory results are obtainable by determination of both output and input under fixed load conditions. Measuring the rate of current flow in amperes in the machine leads and the electromotive force across the supply line, and multiplying the value of these factors will give the input in watts.

In order, however, to determine the number of watts delivered at the pulley, or in other words, the output of the motor, the torque T expressed in pound-feet must be determined. Knowing this value, the work done in one revolution of the armature is equal to 2×3.1416 T ft.-lb. and in n revolutions per minute is equal to $2 \times n \times 3.1416$ T ft.-lb. Dividing by 33,000, the number of foot-pounds required to be expended per minute to develop one horsepower, provides as a quotient the number of horsepower developed, or

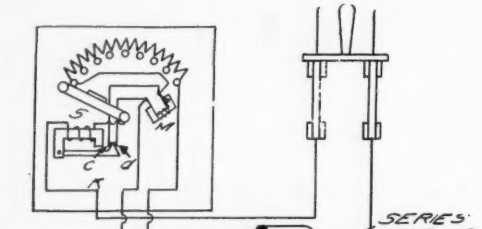


FIG. 115. SHOWING USE OF OVERLOAD RELEASE

$$\text{Work} = \frac{2 \times n \times 3.1416\ T}{33{,}000} = \text{hp.}$$

But, as one electrical horsepower is equivalent to 746 w., this formula may be made to read directly in watts by the multiplication of 746, or

$$\text{Work} = \frac{2 \times n \times 3.1416\ T \times 746}{33{,}000} = 0.142\ nT$$

This is the expression for the output. The efficiency formula, therefore, becomes:

$$\text{Efficiency} = \frac{0.142\ n\ T}{\text{watts input}}$$

As in the case of series-wound machines, the efficiencies of shunt-wound motors are generally dependent upon size, a machine of about ¼ hp. having a maximum efficiency of perhaps no more than 60 per cent, while machines of 30 hp. and larger may have efficiencies of 90 per cent and more. The efficiency curve of a compound-wound motor rises quite rapidly with increasing load, reaches a maximum value at a load somewhat less than the rated capacity of the machine, and then gradually declines.

Efficiency Calculations

If, from experimental data, the various losses in a motor operating at a given speed and voltage are known, the efficiency can be quite readily determined without measurement of the mechanical output. Let us assume that a 110-v., 50-amp. shunt-wound motor has a shunt-field winding resistance of 40 ohms, an armature winding resistance of 0.11 ohms, and a stray power loss at the prescribed speed and voltage of 700 w.

The input of this machine is equal to 50 times 110 or 5500 w.

Current flow through the shunt-field winding is equal to the applied voltage or 110, divided by the resistance of the winding, or 40 ohms, or 2.75 amp., which squared and multiplied by the value of the resistance, 40, gives as a result 302.4 w., the loss occurring in the shunt-field winding.

At rated capacity the machine takes 50 amp., but as 2.75 amp. as indicated above are ultilized to energize the shunt fields, $50 - 2.75$, or 47.25 amp. pass through the armature winding. The resistance of this winding, according to the specifications given is 0.11 ohms, thus making the armature $RaIa^2$ loss equal to 0.11×47.25^2, or 245.58 w.

The total losses are then equal to the sum of 700,302.4 and 245.58 w., or 1247.98 w. We, therefore, have

$$\text{Efficiency} = \frac{5500 - 1247.98}{5500} = \frac{4252.02}{5500.00} = 0.773$$

$= 77.3$ per cent.

Let us further consider the case of a similarly wound motor but equipped with a series field and connected so as to be of the short-shunt compound-wound type. The series field resistance may be assumed to be equal to 0.05 ohms, thus introducing a loss due to this winding element of $0.05\ (50 - 2.75^2)$, or 111.63 w.

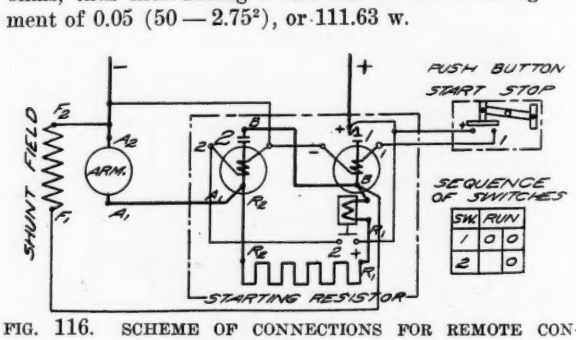


FIG. 116. SCHEME OF CONNECTIONS FOR REMOTE CONTROLLED STARTING BOX

The total loss is in this case equal to that of the shunt-wound motor referred to above plus 111.63, or 1359.61 w., and the

$$\text{Efficiency} = \frac{5500 - 1359.61}{5500} = \frac{4140.39}{5500}$$

$0.734 = 73.4$ per cent.

Motor Control Equipment

As already explained, the rate of current flow through the armature winding of a direct-current motor is dependent upon the value of the counter electromotive force and the resistance of the windings which ordinarily is comparatively low. It is thus evident that with the motor at rest and the counter electromotive force nil, excessively heavy current will flow through the armature at the time of starting unless some suitable resistance is introduced between the source of supply and the armature, arranged so, however, as to allow of being gradually (manually or automatically) cut out as the speed of the machine increases. Such an arrangement, commonly termed a starting box, or rheostat, used in con-

nection with a series-wound motor is shown diagrammatically in Fig. 113. After throwing in the main knife switch, moving the starting-box handle to point 1, a flow of current of small value is established through the machine windings and the starting-box handle, resistance elements and holding or no-voltage release magnet M, and as a consequence the armature is slowly set in motion. Gradually the starting-box handle is moved to the right, making contact successively with contacts 2, 3, etc., and thereby cutting out of circuit portions of the resistance until point 11 is reached, when the motor, as is evident, will be connected directly across the supply lines. When in contact with point 11, the starting-box handle is retained in place due to the energized state of the no-voltage release magnet M, which, as may be seen, remains connected in circuit as long as any current passes through the machine windings. Frequently the no-voltage release magnet is connected directly across the supply lines so as to insure an unvarying degree of magnetization and holding power.

To stop the motor, the main switch is "pulled," the no-voltage release magnet "killed" and the starting-box arm caused to return to the position of start by the action of a coil spring with which it is equipped.

Typical starting-box connections applicable to both shunt and compound-wound motors are illustrated in Fig. 114. In this case, the no-voltage release winding is connected directly across the supply lines and in series with the shunt-field winding immediately the starting-box handle is brought to the first point. This also brings the armature winding and starting box resistances in series

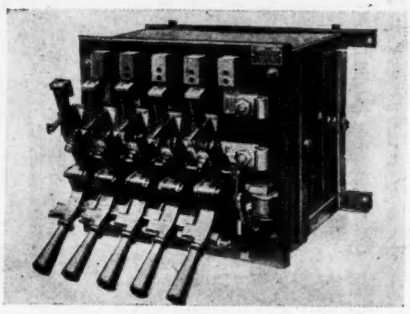


FIG. 117. STARTING BOX FOR USE IN CONNECTION WITH LARGE MOTORS

across the supply lines and slowly the armature comes up to minimum speed; further movement of the starting-box handle to the right results in the cutting out of resistance in the armature circuit and the cutting in of resistance in the circuit made up of the no-voltage release and shunt-field windings, thereby gradually decreasing the flow of current through the shunt-field winding and the strength of the fields. It is thus evident that as the armature comes up to rated speed, acceleration is assisted in a slight degree by the introduction of the resistance in the shunt-field winding.

Where the motors to be controlled are of appreciable size, the use of a series of successively closed manually operated switches such as shown in Fig. 117 is preferable. Interlocks are employed to prevent closure of these switches in any but the regular order.

Overload may be guarded against by the employment of a so-called overload release connected as shown in Fig. 115 in series with the armature. With an excessive flow of current, electromagnet S attracts armature K, the end of which, bridging contacts c and d, short-circuits no-voltage release magnet M. As a result, the starting-box handle is released and by means of a spring provided for that purpose is brought back to starting position, thus stopping the motor.

Operatives in industrial plants are as a rule not familiar with the proper mode of handling electrical machinery, and as a consequence of this, and frequently also due to indifference and carelessness, much damage is done to motors equipped with the regular form of manually operated starting box. To overcome this, remotely controlled starting boxes in which the acceleration of the motor is beyond the control of the operator are available. A scheme of connections for one of these devices is illustrated in simplified form in Fig. 116.

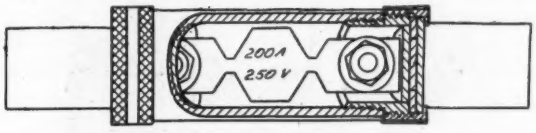


FIG. 118. ENCLOSED FUSE OF THE REFILLABLE TYPE

In this arrangement, two primary relays are employed, one for the closing of the switch which connects the armature and the starting resistance in series, and one for the closing of a second switch for the short-circuiting of the resistance when the motor has reached rated speed. Pressing of the "start" button at the right energizes relay 1, and as a consequence, switch 1 is closed, thus cutting armature and starting resistance in series across the supply lines. An auxiliary series relay is directly below relay 1 energized by the flow of current through the armature circuit. At start, this current flow is comparatively heavy but decreases as the armature gains in speed. At a predetermined value of armature current flow (that is, armature speed), the plunger of the series relay drops bridging contacts designated 2 and + in the diagram.

Accordingly, current is caused to flow through the windings of relay 2 which, being energized, closes switch 2, thus short-circuiting the starting resistance and cutting the armature directly across the supply lines. The actual number of relays employed in an arrangement of this kind is dependent upon the number of starting resistance sections employed.

Protective Devices

THE EARLIEST protective device, and the one most generally used in connection with motors of small and medium capacity, is the fuse, which ordinarily consists of a short strip or length of wire of such metallic composition and sectional area as will allow the passage only of some predetermined maximum value of current. Current flow in excess of the rated capacity will cause the fuse to melt, or as it is frequently termed "blow," and thereby open the circuit and prevent further passage of current. Formerly fuses of the open type, that is, fuses mounted on porcelain bases and exposed, were used almost exclusively; but, due to the fire hazard accompanying the blowing of such fuses, they have been practically

superseded by those of the enclosed type such as illustrated in Fig. 118. Some of these when once blown are of no further utility, while others are of such construction as to allow renewal of the fuse element, thus providing an indefinite length of life for the containing cartridge.

The primary advantage of the fuse lies in the fact that but momentary overloads fail to cause it to function, thus insuring continuity of service unless the overload continues for an appreciable length of time. When this occurs, however, the fuse will blow, the motor stop and service will be interrupted until a new fuse is inserted. In many plants, this may prove undesirable, and frequently costly. To overcome this disagreeable feature, therefore, various forms of mechanical circuit breakers

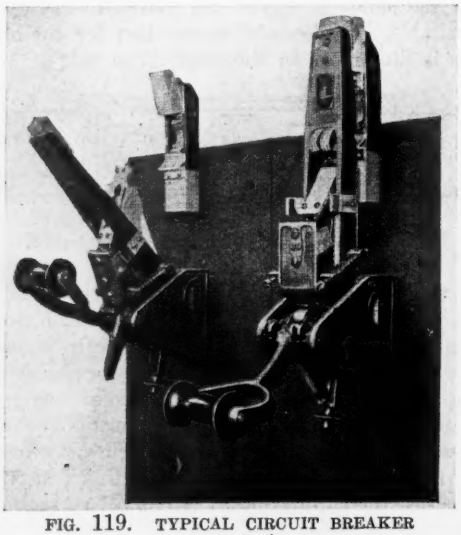


FIG. 119. TYPICAL CIRCUIT BREAKER

such as illustrated in Fig. 119 have been developed. These are essentially knife switches equipped with a solenoid through which all or part of the current carried by the switch passes. Current in excess of a predetermined value energizes the solenoid to such an extent as to act upon a plunger, which due to being drawn into the solenoid, trips a catch, which in turn releases the switch member and thus opens the circuit. The action of such a circuit breaker is almost instantaneous once the flow of current exceeds the predetermined tripping value, unless the device is especially designed and constructed to do otherwise.

Questions and Problems for Review

Explain what is meant by the efficiency of an electric motor. Prove that the approximate theoretical efficiency of an electric motor is as the ratio of the counter to the applied electromotive force.

2. A 220-v. 75-amp. short-shunt compound-wound motor has at prescribed speed and voltage a stray power loss of 1035 w., an armature resistance of 0.015 ohms, a shunt-field winding resistance of 60 ohms and a series-field winding resistance of 0.09 ohms. Calculate the efficiency of this machine.

3. Make a sketch showing the internal and external connections of a manually operated starting box used in connection with a compound-wound motor.

4. Describe the action of a typical circuit breaker.

The Oxide Film Lightning Arrester

THE OXIDE film lightning arrester has been developed as the result of the demand for an arrester that would give the same amount of protection as the aluminum arrester, without the necessity of daily charging. This charging consists in connecting the aluminum arrester to the line for short spaces of time each day, in order to renew the nonconducting film on the plates, and has made this arrester impractical for installation in isolated places. The oxide film arrester does not require daily attendance to insure the maintenance of its protective qualities. Therefore, although it is practical for almost any application, its principal field is in places where daily attention is not available, but where good protection is required.

Lately there has been a large increase in the number of isolated stations and substations, whose class of service calls for highly reliable protection, and it is here that the oxide film arrester finds its usefulness.

The construction of the arrester is very simple, requiring no oil or electrolyte, and requires very little work to install it. It consists of a stack of cells connected to a sphere gap. In the outside type, these cells and sphere gaps are thoroughly protected from the weather, which insures a uniform spark potential under

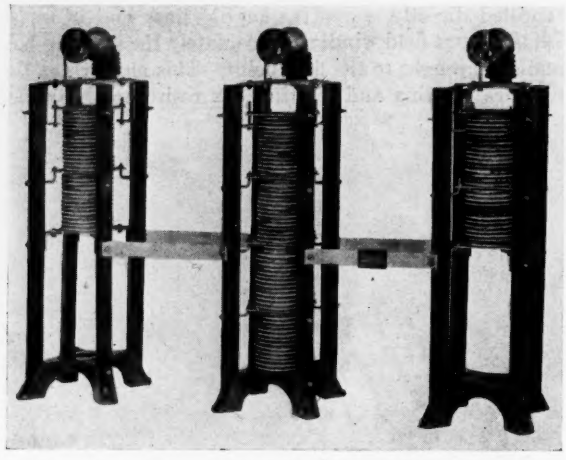


FIG. 1. OXIDE FILM ARRESTER FOR INDOOR SERVICE ON 3-PHASE CIRCUITS

all climatic conditions. The cells themselves consist merely of two thin steel plates or electrodes spun on a porcelain ring, which acts as an insulator, the space between, about half an inch, being filled with lead peroxide. The electrodes are further provided with an insulating film of varnish, or some similar compound which gives a uniform insulated surface.

The operating principle depends on the fact that lead peroxide, which ordinarily is of low electrical resistance, is unstable at a temperature of about 250 deg. C, and forms a lower oxide, called litharge, of high resistance to electric current. Thus, although its action is thermal instead of electrolytic, it functions in a good deal the same way as an aluminum cell arrester by preventing the flow of dynamic current. What actually happens in practice is, that at a potential of about 300 v. per cell, the insulating film prevents any noticeable amount of cur-

rent from flowing under normal conditions. As soon as the voltage rises above normal sufficiently to spark on the gaps, the film is punctured by very small pin holes and the lightning flows to ground, since it meets with very little resistance. When the dynamic current attempts to follow, the smallness of the punctures causes great concentration of current at those points. The consequent localized heating is enough to cause the lead peroxide to break down, forming litharge, in the path of the current, thus effectually blocking it.

The film reseals itself, in about one four-thousandth of a second after the excess lightning voltage has ceased. Since the powder is a poor heat conductor, the formation of these high resistance plugs is confined to the actual area surrounding the puncture.

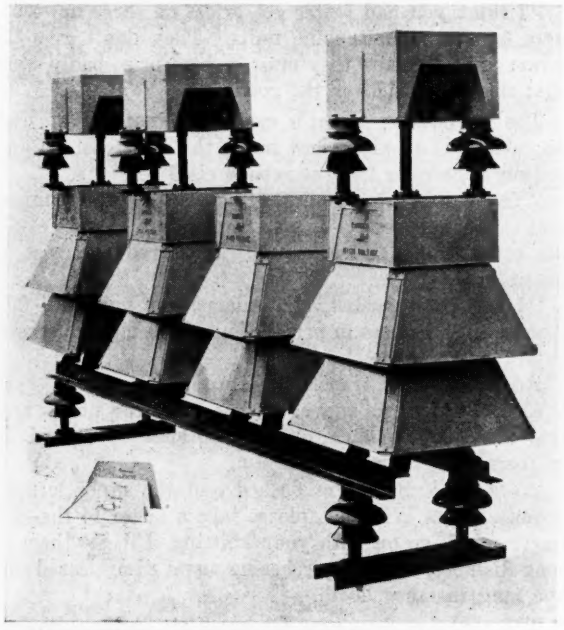


FIG. 2. OXIDE FILM ARRESTER FOR OUTDOOR SERVICE ON 3-PHASE CIRCUITS

Since this action is due to the inherent chemical property of the material between the electrodes, and it is this material itself which forms and reforms the insulating film, there is no action similar to the gradual dissolving of the film which takes place in the aluminum arrester, but it is, in a sense, permanent, requiring no daily charging.

An installation of this arrester consists of a stack of these cells, piled up on top of each other, the number depending on the voltage of the circuit, with sphere spark gap in series. The stacks are arranged in suitable racks with the spark gap placed on top. For outdoor installations the spark gaps as well as the cells are shielded from the weather. As only a comparatively small arc is formed at the gap with this type of arrester, the protective casing is made quite compact.

U. S. CIVIL SERVICE COMMISSION announces an examination, July 6, for junior physicist, to fill vacancies in the Bureau of Mines, Department of the Interior, at $1500. Apply for Form 1312.

"Per Cent Reactance"

BY L. L. MEYER

THE "per cent reactance" of a coil in an alternating-current circuit is the percentage ratio of the drop in volts across the coil, when full-load current flows through it, to the voltage of the system. For example: If, in a certain system, the full-load current is 100 amp., and the normal voltage is 10,000 v., the drop in a coil having 5 ohms reactance would be: 5×100, or 500 v. The per cent reactance will then be $500 \div 10{,}000 = 0.05$, or 5 per cent.

Goddess of Light

BY J. B. DILLON

ROUND and round she goes—her pathway known so well—dropping bright lights here and there, the darkness to dispel. Far as the eye can see, high up on buildings tall, deep down in cavernous pits —she gives bounteous light to all. Her power is almost

FIG. 3. TYPE OF LIGHTNING ARRESTER CELL

omnipresent, yet requires but little space. Moving tramways and elevators carry you from place to place.

Heat is at your command. Without her, motors are inert. Were it not for her benefits, 'twould be a desolate earth. The telegraph seeks her favor, likewise the telephone. She is loved by multitudes in every clime and zone. Her requirements, after all, are simple. Regardless of the wealth bestowed, she only asks for proper maintenance. The Goddess of Light is—a Dynamo.

IT WAS the noon hour at the Power House. The boys were enjoying their usual smoke and confab. Politics seemed to hold sway, one fellow declaring that if the Presidential election was dependent upon the refrigeration plants, he could name the winner.

"Ah, quit yer kiddin', Bill."

"Dere's no kid to it."

"Name him, then."

"Well, ain't dey in favor of Brine?"

Good Housekeeping Increases Water Power

TRASH IS NOT ALWAYS CONDUCIVE TO HIGH TURBINE EFFICIENCY. BY J. S. CARPENTER

RRRR-RING! The telephone rang ferociously. The general manager was calling the plant superintendent, Mr. Adams. While we turn aside from the unprintables, let us take a look at the office. Behind a double barreled battery of card index files and flanked on two sides by large framed curve sheets, sat the super. Two sweet-faced stenographers adorned the place besides the fine, up-to-date furniture. Mr. Adams' immense desk easily dominated the scene, the whole being neatly spread out on a rug that sort of seemed out of place.

Mr. Adams was a careful man. From his files crammed with red-hot cost data, etc., he could tell you the exact cost of a 1/16-in. split pin or a new running mate to the three 4000-kw. water wheel-driven generator units. Plant operation economics was something the super had his own ideas about. His periodical inspections extended from the forebay to the tailrace and what he thought needed attention got it, and nothing else. This being popularly called efficiency, you have

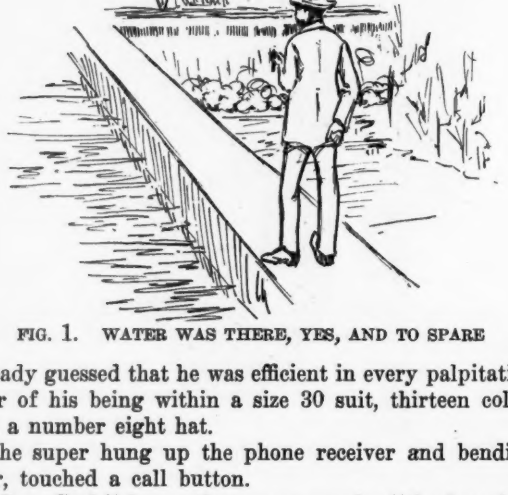


FIG. 1. WATER WAS THERE, YES, AND TO SPARE

already guessed that he was efficient in every palpitating fiber of his being within a size 30 suit, thirteen collar and a number eight hat.

The super hung up the phone receiver and bending over, touched a call button.

"Say, Carl," began the super gravely, "the boss just called up and threw a fit because the output went down 200 kw. again. Get your hat and coat on and we'll go up the forebay and see if there's any water up there."

"As I came by the falls this morning I see they was a sheet o' water a foot thick agoin' over the dam," replied the chief operator.

"That makes just 2000 kw. loss since the plant was put in, only 2 yr. ago," reflected the super.

"But you claimed you got 50 kw. more the time you took out them trash tracks, them grizzlies that you says is nothin' but to hold the water back."

"Well yes, seeing that we had no trouble from leaves, the turbines being so big, 'most anything will go right straight through them," returned the super, now on the defensive.

"Then I s'pose you're figurin' on gettin' a layout o' new runners. That'll mean 15,000 iron men not a'countin' the trouble and shetdowns to git 'em in."

The super made no reply. He had visions of being "up on the carpet" explaining a requisition for three new runners, 30,000 lb. of new, shiny bronze.

His trip to the forebay did not ease his mind any. Water was there, yes, and to spare. While it looked rather enticing for a swim, it was a pity that it could not lure a few more hundred kilowatts out of those turbine-driven units down in the power house. Returning to the power house, he walked slowly into the office of the company's purchasing agent, Mr. Bernstein.

"Good morning, Mr. Adams," Bernstein greeted, "you look worried; what can I do for you?"

"I think you had better get prices on three new runners for the main turbine units. They don't give the power any more and they must be bent or so badly worn that they can't deliver the goods."

The purchasing agent's eyebrows went up at least an inch. "You know how much that will cost. Can't we buy it cheaper from somebody else?"

"The builders have all the patterns for the runners and they could supply them cheaper than anyone else—all other things being equal. I figured the cost at about $15,000."

"I beg your pardon, Mr. Adams, you mean $20,000. The recent advances in prices of all goods mean increases in our business too."

Adams studied Bernstein through narrowed eyes. "Well," added the super, arising, "get the prices anyway and I'll take them over to the boss. We need the runners, that's sure."

"Yes, sir," Bernstein flashed and the super left the room. "Miss Williams, please take a latter to the—no, never mind, go on with your knitting, I'll get them on long distance." The purchasing agent disappeared into the long distance booth.

The next five days brought but little further development. The turbine company's salesman had been on hand to get that fine, juicy repair order and between him and Mr. Bernstein they decided that new runners were needed. Mr. Bernstein assured the super that he had gotten a rock bottom price and that he had beat the salesman down $5000 and cut the time of delivery in half, getting a net price of $21,000, net 30 days or cash less 2 per cent.

So in due course of business, the requisition was made out and attached to the formal quotation from the turbine company and conveyed by Mr. Adams to Mr. Marshall, vice-president and general manager of the Long Lakes Power Co.

"Whew!" whistled the manager with bulging eyes, then gasping at the size of the price.

"You know how the power has been dropping off lately and we can't lay the trouble to anything else," volunteered Adams in a subdued tone.

"Well, all right, tell Bernstein to put the order through," drawled the boss with reluctance and handing the papers back to the super, he turned to other matters.

Needless to say, the expected verbal duel between the boss and the super had not come off, much to Adams's satisfaction. Was the boss beginning to have more confidence in him? The way in which the requisi-

tion had been passed gave his pride no little boost. The routine of getting the order to the manufacturers was given to Bernstein who complied with his usual care in putting through big orders. Particular emphasis was placed on the delivery and in view of the juicy piece of business, the turbine company promised to do its best.

But that order did not lie well on the boss's mind. Several times it came back to him forcefully, but he scouted the suggestion, recalling having had to "call" the super a dozen times about the power being short and the sooner that there was full power, the sooner could a few more profitable blocks of load be taken care of. Several matters like this continued to bother his mind.

One of these was his car. It had been "cranky" of late and the clutch would let go every so often. He had driven it 6000 mi. since its last overhauling and besides that, it could stand painting, too.

His friend the garage man did not share his views. Garage men never do, if they can see a way for you to spend money. "It's gone to seed, and ought to be sold while it can stand up yet," he assured the boss. "Just step over this way and see the 1920 edition. Slickest thing yet; push button control, all the comforts of a palace."

"It sure is all you say," granted the boss with a sigh, "but I can't swing it now, things are too high."

"You want to be up to date, and maybe I could give you a little time. Yes, I wanted to tell you, your purchasing agent, Mr. Bernstein, has just given his order for this model and I guess your note is just as good as his."

"So Bernstein bought a sea-going hack like that?" questioned the boss with sudden and increased interest.

"Yes, and he's going to be mighty proud of the way she performs!"

"What terms did you give Bernie? Can you give me as good?" the boss continued and by this time he was much more sociable.

"In strictest confidence, Mr. Marshall," the garage man confided in almost a whisper, "he paid me ten per cent. cash and the balance in a note—90 days. But let me take you home in this car now and we'll talk prices later."

Marshall got in and after 20 min. of comfort, luxury and speed he alighted at his door. But as the garage man left, a smile was on his face and a new, crisp check reposed in his wallet.

During the evening Mr. Marshall gave the new power project that his company had just acquired, some highly-concentrated thought. He thought out some changes in the layout that could be taken care of with little extra trouble and that would cut the cost about 2 per cent, and 2 per cent these days is something worth thinking about. But that had to be done soon, while the engineers were still on the job, staking out the proposed dam, and making borings on the site. Adams was just the man to send, and why not? He would 'phone him right away and instead of Adams being at the Long Lakes plant tomorrow, at noon he would be eating a square meal on the company at the Sparkling Falls Hotel, just a half mile from the new power site.

Then he put in another call for a former employe, an elderly, fatherly sort of an operating engineer who started up the Long Lakes plant 2 yr. ago. This man shortly afterward was unfortunate enough to fall into much money and that crippled him for further work. But Mr. Thomas would, he assured Mr. Marshall, cut out enjoying life for a few days and spend a little time at the Long Lakes plant during the absence of Mr. Adams. Mr. Marshall told him incidentally that the present runners had gone "flooey" and that new ones would shortly be on the way, when he would be pleased to have the service of Thomas again in an advisory capacity, to make sure that everything would start right.

Mr. Thomas was one of those old-school engineers who had forsaken steam engineering and had taken up hydroelectric plant operation. He had served several big plants creditably and some of the manufacturers had employed him to start off new plants as he had also done for the Long Lakes people. Thomas was a young man, though not lately, but still just as fat and "sassy" as he had ever been, besides being able to

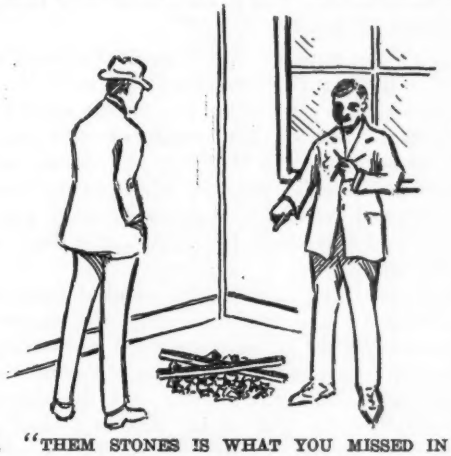


FIG. 2. "THEM STONES IS WHAT YOU MISSED IN YOUR HOUSE CLEANIN'S"

take in a situation at a glance and tell 'em where to get off. His very size compelled respect and awe and nobody ever doubted that he would have made an excellent heavyweight, only his parents stunted him with music lessons while too young to know better and fight back, instead of educating him for the ring.

So the next day found the super at Sparkling Falls and big Mr. Thomas on the throne and in power at Long Lakes. The super wasn't exactly tickled with his new errand and, on the other hand, Mr. Thomas was beginning to wonder why they hadn't called in a licensed plumber and done the job right, instead of bothering a gentleman of leisure.

For Mr. Bernstein, the morning's mail contained a thrill of excitement in the form of a letter from the turbine company stating that their pattern storage loft had burned down and that they would have to make new patterns for the runner. This might take them two weeks longer, but they promised to put on a night shift and try to keep within the date. To this, Mr. Bernstein dictated a wire reply emphasizing the precarious position of the power company and calling upon the manufacturers to do their utmost.

About two o'clock, just as Mr. Marshall had seated

himself in his swivel chair, the generous form of Mr. Thomas crowded the boss's office. The boss was slightly surprised to see Thomas, who apparently had come unescorted and unannounced by the office boy. But whatever the form was in that office, Thomas had a pitying sort of contempt for forms, calling cards, and office boys. If he had encountered one along the route, said office boy would have predicted a thunder storm by the immense shadows cast and flown for cover.

Now he sat on a chair in Marshall's office and thundered out, "How much'll yer give me if I show yer 12,000 kw. on the meters by five o'clock with the present runners?"

"I'll give you the key to my cellar!" snapped the boss, stunned for the moment, but quickly recovering.

Thomas shifted his chew, nearly drowned the cuspidor and calmly replied, "I mean business, not booze."

By the look in the man's eye, Marshall saw he was talking turkey and wrote down three figures on a pad. Thomas got up, strode to the door and pausing there a moment, croaked, "You're on. Come over to my parlor in about 10 min.!"

The mail boy came in with a handful of mail on top of which was the turbine company's letter to Mr. Bernstein and a carbon copy of the purchasing agent's reply. Mr. Marshall digested the import of both and then walked rapidly over to the generator room. On the way, he met the chief operator who told the boss that he had 'phoned the trolley company he could give them 2000 kw. and having a favorable reply, had hooked their line on.

Thomas not being in sight, Marshall stepped over to the switchboard and read the story the meters told. In the meantime the big man appeared and waited until the boss turned around and saw him. Marshall handed him the turbine company's letter with the copy of the reply. Getting the gist of it, Thomas looked at the boss over his glasses, pointed to the meters and then gave him back the letters, saying, "Kill it dead."

It was four o'clock and just time enough to squeeze in a long distance call nicely, allowing time for the operator to make three or four bum guesses before she got the number. With that off his chest, the boss confirmed it by mail and kept the copy of the confirmation in his private file.

In the morning, two days later, Mr. Adams returned to the Long Lakes plant. He was astonished to see a pile of stones in one corner of his office on top of which were four short pieces of what might have once been three by fours but now quite chewed up. He got hold of the porter who told Mr. Adams that Thomas had given him strict orders not to touch that pile, "or he'd break his neck." Somewhat taken back, not to say humiliated, but gradually getting hotter and hotter under the collar, Adams waited for developments. He did not have to wait long.

In the meantime, Mr. Marshall came down the hall and as he passed Bernstein's office he heard the following:

"I want to cancel the order for that car; you didn't order it yet, did you? You put the order in by wire? I'm awfully sorry—my aunt—I mean my uncle died yesterday and he left me a car—can't use two—no I don't want to trade his in on account—I'll stop in and see you at twelve—"

And advancing a few steps further, he heard Adams sputter like a machine gun, giving Thomas his unbiased opinion. Thomas waited until Adams shot his wad and then brought up the heavy artillery.

"Now listen, Mr. Adams, don't give me any of that childish chatter, Marshall cancelled the order for those new runners two days ago and we've been carryin' full load ever since. Them stones is what you missed in your house cleanin's, you probably never thought that it was the runner that made the shaft go 'round and it probably was too big for you to see—now wait a minute—let me say my piece—you can't expect them runners to vent their little ocean o'water when they's half stopped up down the ends of them long vanes—could yer?

"An' now I'm goin' away from here; you don't treat me at all nice after savin' yer all kinds of money. Yer a thankless critter, that's you. But the next time you cleans house, sonny, take a look at the sight of the corners, that's it, jes' sweep in the corners too. I'm agoin' over after my check right now an' I'll be darned if I ever give up the pleasure o' life to help you outa a scrape!" With that Mr. Thomas strode out, slamming the door so that it bent outwards, while Mr. Adams took up the latest copy of "Substation Guff" to cool off the white heat.

The porter shuffled down the hall and into Bernstein's office. Handing him his pathetic wire appeal to the turbine company to hurry the delivery of those runners, the darkey mumbled, "Ah found dis yere paper down de hall wif yo' name on hit. Do yo'-all want it?" Bernstein gave one glance at the paper, tore it out of the unknowing darkey's hand and crushed it in rage. Meanwhile the "cullud gemman" fled for safety.

Correction Note

L. G. Jenkins, of Jeddo, Pa., has called my attention to an error in my article which appeared in Power Plant Engineering under date of December 1, 1919, entitled "Steam Pipe Support." The formula toward the bottom of the first column on page 1056:

$$M = \frac{144\ W\ L^2}{8}$$

Should read:

$$M = \frac{12\ W\ L^2}{8}$$

This error unfortunately causes the value of the constant "C" as given in the table in the opposite column, to be 12 times too large.

To say the least, I regret this error exceedingly. The error of course in no way affects the method of determining steam pipe supports which I outlined in the article. H. M. Brayton.

U. S. Civil Service Commission announces an examination, July 6, for assistant mechanical engineer, to fill vacancies in the Bureau of Mines, Pittsburgh, Pa., at $1680, and in positions requiring similar qualifications. Apply for Form 1312.

Safety About Transmission Machinery

PREPARED BY THE ENGINEERING DEPARTMENT OF THE NATIONAL SAFETY COUNCIL

WHEREVER there is power-driven machinery, arrangements should be provided at a convenient point or points, in each department or workroom, whereby either the entire power supply in that department or room may be cut off as a whole or the one or more lines of shafting used in driving counter shafting or directly driving machines, may be cut off independently.

Friction clutches, tight and loose pulleys, motor stops, and in some instances engine stops are used to accomplish this.

A safety placard should be prominently displayed, calling attention to the stopping and starting machinery.

SHAFTING

ANY PORTION of a horizontal shaft, which is 7 ft. or less from the floor or working platform or which must be approached while in motion should be guarded on the sides and bottom or protected by a standard railing insuring at least 15 in. and not more than 20 in. horizontal clearance from the nearest moving part.

The methods of guarding vertical and inclined transmission shafting vary somewhat. For instance, the State of Pennsylvania requires that such shafting be encased or guarded to a height of 6 ft. from floor or working platform, or be guarded by a standard railing with not less than 15 in. clearance. The State of New Jersey has adopted the same rule except that a standard railing may be used if placed 18 in. or more from any moving part. The State of Massachusetts specifies that vertical transmission shafting exposed to contact shall be encased to a height of 6 ft. from the floor; the Massachusetts Rating and Inspection Bureau also requires that such shafting be encased to a height of 6 ft. from the floor or working platform.

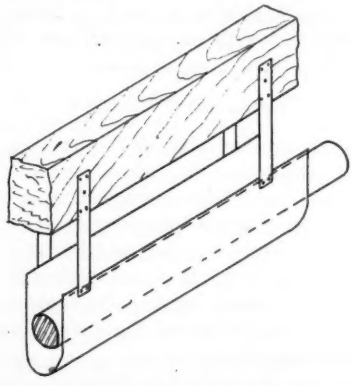


FIG. 1. ANY PORTION OF A SHAFT LESS THAN 7 FT. FROM THE FLOOR SHOULD BE GUARDED SIDES AND BOTTOM

The majority of engineers commenting on this rule favor encasing such transmission shafting to a height of 6 ft. in preference to using a railing at a clearance of 15 in.

The distance that a guard is placed from a moving part (whether it be shaft, belt, or pulley) governs the size of openings allowed in the protecting device. When there are but a few inches clearance (Pennsylvania places it at 6 in., Ohio, New Jersey and Massachusetts at 4 in.) no opening through the guard larger than ½ in. should be allowed. This is to prevent the projection of fingers or material through the guard into the moving machinery. When the distance is greater than 4 or 6 in. as the case may be, and less than 15 in. (New Jersey places it at 18 in.) from the moving parts, the openings in the guard may be 2 in. in either direction though the majority seem to favor that such openings be not greater than 1½ in. in either direction.

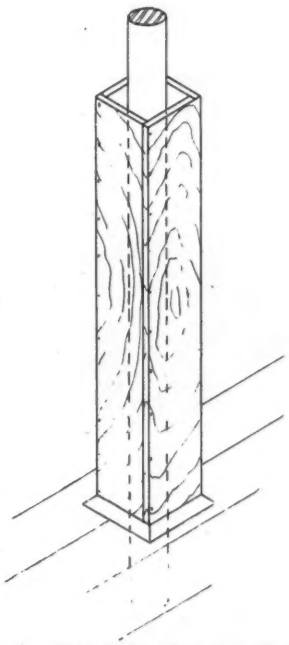


FIG. 2. VERTICAL SHAFTS SHOULD BE SURROUNDED BY A CASING 6 FT. IN HEIGHT

A guard should not be placed so far from the thing guarded as to invite the workmen to get between the guard and the object guarded, or so far as to make it inconvenient to reach bearings, etc., while standing outside the guard. It is recommended that the maximum distance at which a guard be placed from the thing guarded should be 20 in.

The Council advocates the following safe practices as to the height of guards and the size of openings in the same:

Distance from thing guarded	Height of guard	Size of openings
15 to 20 in.	3 ft. 6 in.	Railings
6 to 15 in.	6 ft. 0 in.	1½ in.
0 to 6 in.	6 ft. 0 in.	½ in.

When the moving parts are less than 6 ft. above the floor, they may well be guarded over the top instead of carrying the guard to a height of 6 ft., or a 3 ft. 6 in. railing should be placed at least 15 in. and not more than 20 in. from the nearest moving part.

When a shaft passes through the floor (or when any guard is placed around a floor opening) a 6-in. solid section or toe-board should be placed at the bottom of the guard to prevent objects rolling or being kicked through the floor opening.

(Many engineers advocate that all projecting shaft ends, regardless of location, be cut off or equipped with stationary protective casings, if accidental contact is not prevented by the shaft guards.

The State of New Jersey makes this a mandatory rule. Pennsylvania requires that shaft ends within 6 ft. of the floor of platform shall be guarded. Massachusetts places the distance at 7 ft. and limits the rule to shafts projecting more than 2 in. from bearings.

The Council believes that the best practice is to cut off, or guard as above, all projecting shaft ends where there is a possibility of clothing or material catching on them, if the projection is 1 in. or more or if there is an unfilled keyway in the end of the shaft.

Couplings, Collars, Keys and Set Screws

Shaft couplings and set collars should be of a safety type, without projecting bolts, set screws or other dangerous projections or be suitably guarded.

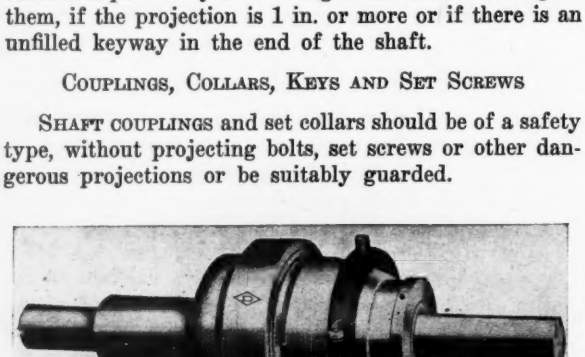


FIG. 3. THIS IS A SAFE TYPE OF COUPLING; ALL MOVING PROJECTING PARTS ARE ENCLOSED WITHIN THE CIRCULAR CASING

Clamp couplings should be guarded by a cylindrical sleeve the full length of the coupling.

Jaw clutch couplings should be provided with a cylindrical sleeve which at least covers the jaws.

Universal and flexible couplings should be so guarded or encased as to remove all hazards.

Friction clutch couplings should have their operating mechanisms, where exposed, completely guarded.

Keys exposed to contact should be made flush or guarded.

Keyseats in ends of shafts, where exposed to contact, should be filled or guarded.

Set screws on revolving parts, where exposed to contact, should be counter-sunk or covered by a guard, or a headless set screw should be used. No part of the set screws should project above the surface.

The above guards should be so designed, where practicable, as not to revolve with the part guarded.

Bearings

Accurate alinement of bearings is an important factor in safety and in economy of operation. Frequent inspections of bearings and hangers are desirable. They should be so equipped with oiling apparatus that there will be no occasion for the oiler to come into dangerous proximity with shafting when it is in motion.

Pulleys

Pulleys should be spaced at a slightly greater distance from bearings or hangers or other pulleys (except tight and loose pulleys), than the width of the belt, so that in case the belt slips off the pulley it will not become wedged between the hanger and the pulley, or between two pulleys, thus pulling down the line shafting. If it is impracticable to space pulleys further from a hanger or another pulley then the width of the belt, the intervening space should be guarded in such a way that it will be impossible for the belting to become wedged should it slip the pulley. This may be done by placing a spool 4 in. larger in diameter than the pulley on the side of the pulley adjacent to a hanger or another pulley or by the use of a belt hanger.

Pennsylvania and New Jersey provide that when bearings are not self-oiling and the clearance between the pulley and the bearing on line shaft is 36 in. or less, the pulley shall be completely guarded on the side nearest the bearing and all keyways in the shaft between such pulley and bearing shall be substantially encased or properly filled. A simple and effective guard may be formed by binding and lapping a steel plate.

Pulleys should be a little wider than the width of the belt.

Pulleys should be frequently inspected for cracks which are likely to develop in the arms and rims. When a crack occurs a piece of the rim may be thrown out by centrifugal force and cause a serious accident. Testing by hammer will usually disclose any defects.

Idler pulleys or tighteners used to tighten belts on pulleys, if provided with counter weights, should have counter weights guarded or enclosed.

Transmission Gearing

In this term are included all forms of spur wheels. pinions, bevel wheels, mortise wheels, helical, skew and worm gears, rack and pinions, sprocket wheels for chain drives, etc. Such gearing wherever located should be strongly and completely encased, or when this is impracticable should have a band guard provided with side flanges extending inward beyond the root of the teeth. Where there is a spoke hazard the gears always should be enclosed on exposed side.

Construction of Guards

Metal is preferable to wood in the construction of guards. Wooden guards, especially if oil soaked, increase the fire hazard; they also are more expensive in upkeep. Metal guards are practically indestructible, wear better and are more substantial. Where guards are subjected to acid fumes, wooden guards may be necessary, however.

All guards should be of rigid and substantial construction. The railing guards placed from 15 to 20 in. from the moving parts, should be of the double type with the top rail 3 ft. 6 in. from the floor and an intermediate rail midway between the top rail and the floor.

In some states it is illegal to "remove, displace, damage, destroy or carry off any safety device, safeguard, notice or warning" furnished by the employer, "or interfere with the use of any method or process adopted for the protection of any employe."

Back Pressure

Its Meaning and Significance in Refrigerating Practice. By A. G. Solomon

WHAT DOES the term "back pressure" mean as used in the refrigerating plant?

It really is the amount of pressure that exists in the evaporating coils and on all of the system that is not subjected to the condenser pressure. That is all true, but it is far from being a clear explanation of what back pressure really means.

The back pressure that is maintained in any cold storage or ice plant has more direct effect on the economical as well as on the successful operation of the plant than any other item.

Back pressure determines the capacity of the machine. It also controls the temperature at which it is possible to carry cold storage rooms. Just let the engineer of a cold storage warehouse attempt to hold a small sized room at a temperature that is 20 deg. F. lower than any other room in the plant and he will learn much about back pressure and its bearing on economy.

If a general cold storage and ice plant is operated and the lowest temperature is that of the brine in the ice tank, it would be a losing proposition to attempt to maintain a temperature of zero in one room.

At atmospheric pressure, water boils and turns into steam at a temperature of 212 deg. F. At any temperature below 212 deg. water will not change its form into the gaseous state unless the pressure exerted on its surface is lowered.

To change water into steam at a temperature below 212 deg. the pressure must be lower than atmospheric. A vacuum must be formed and the greater the vacuum, the lower the temperature at which the water will turn into steam; and going the other way, above atmospheric pressure, the higher the pressure exerted on the water, the higher will be the temperature at which steam is formed.

Referring to the table, "Properties of Saturated Steam," we find that the boiling temperature of water is 212 deg. F. at atmospheric pressure; 273 deg. at 30 lb. gage pressure; and 327 deg. at 85 lb. pressure. And the vacuum table shows us that when the mercury column shows 29.8 in. of vacuum, the water turns into steam at a temperature of 34.42 deg. F.; at 15 in. of vacuum, the temperature is 179 deg.; at 5 in., 202 deg.

The foregoing facts concerning water and steam, pressure and temperature are all readily understood by all operating engineers. It will surprise many to know that the action of ammonia is no different from the action of water. Of course, the corresponding pressures and temperatures are different; but the principle is the same.

To boil (vaporize) liquid ammonia at atmospheric pressure, the temperature must be at or above 27 deg. F. below zero. This means that pure liquid ammonia will change its form into vapor at a temperature of 27 deg. below zero when the pressure exerted is just that of the atmosphere. The pressure gage shows zero when the pressure is atmospheric. This boiling point of liquid ammonia corresponds to the boiling point of water only the temperature is 239 (212 + 27) deg. lower.

Now we will raise the pressure on the ammonia and note that the temperature must be increased also. With a gage pressure of about 5 lb., the temperature is 16 deg. below zero. At 15 lb. gage pressure, the temperature is just about zero. This pressure-temperature relation exists, and because of the simple fact that it does exist we must control the back pressure so as to maintain the ammonia temperature best suited for the operating conditions of the plant.

It is evident that a room temperature of zero cannot be held if the evaporating temperature of the ammonia in the coils is above zero as would be the case if the back pressure were 15 lb. With 15-lb. back pressure and a room temperature of zero, the temperature of the ammonia in the coils and the air in the room would be the same and there could be no exchange of heat.

As a general rule, the temperature of the ammonia in the evaporating coils should be about 10 deg. lower than the air surrounding the coils. This temperature difference allows the heat to flow from the substance to be cooled to the ammonia. As the rate at which heat units pass to the ammonia is counted at so many units per hour per square foot pipe surface per degree temperature difference it is readily seen that the greater the temperature difference the more heat will pass to the ammonia.

There are instances where good results are obtained in cold storage work and the temperature difference is only 2 deg. F.; but in such cases, the amount of coil surface is very great when compared with the cubic feet of room space.

As an example we will take a plant operated on the direct expansion system and where all the rooms, except a very few, are held at a temperature no lower than 20 deg. above zero. The few rooms require that a temperature of zero be maintained to preserve the produce that is stored in them.

To have a temperature difference of 10 deg. F. between the ammonia and the atmosphere in the zero rooms, it would be necessary to have a back pressure of not higher than 9 lb. gage. At that pressure, the ammonia will vaporize at a temperature of 10 deg. below zero. In the coils of the 20-deg. rooms, the ammonia temperature need not be lower than 10 deg. above zero to give good results. This ammonia temperature corresponds to a back pressure of 24 lb.

As the capacity of the compressor is greater with the higher back pressure, it is advisable to carry as high a pressure as is possible. Now we will see where the increased pipe surface is needed.

Increased Pipe Surface Required

Since the plant cannot operate in an economical manner with the low back pressure, enough pipe is installed in the zero rooms so that the low temperature can be maintained while the temperature difference is only 2 deg. Then in our example, the ammonia temperature need be only 2 deg. below zero instead of 10. This temperature calls for a back pressure of 14 lb. gage.

When a cold storage room is handled with this close temperature difference, it is important that the coils be kept free of ice and frost. An accumulation of ice and frost is as much an insulating material on direct expansion piping as asbestos covering is on steam pipe.

With a heavy coating of frost on direct expansion piping, the heat in the room cannot come in close contact with the ammonia in the coils and the back pressure must be kept low so as to have great enough temperature difference to cause vaporization.

The most common cause of a compressor freezing up is heavy frost on the coils. Liquid ammonia will pass through the entire length of a heavily frosted coil and will go to the compressor without taking up enough heat to cause complete vaporization.

Desirable Back Pressure

There always has been argument both for and against high back pressure. It depends entirely on the operating conditions of the individual plant what back pressure is best to maintain. It is true that the capacity of the ammonia compressor is based on the weight of ammonia handled. The capacity of the plant as a whole, however, does not always depend on the weight of the ammonia sent to the condenser by the compressor.

To make this more easily understood, we must study ammonia as to its heat absorbing power and also look carefully into the actual amount of ammonia handled by the compressor.

First to be considered will be the ammonia in the evaporating coils. The coils must have liquid ammonia in contact with every foot of their inner surface if the proper heat exchange is to be expected. If sufficient ammonia is not allowed to enter the coil, that part of the coil closest to the outlet will not be doing its duty as the load of heat will have been collected during the passage of the ammonia through the first part of the coil.

We will take a back pressure of zero (gage) and see what results can be obtained. At this pressure, the ammonia evaporating in the coils will have a temperature of 27 deg. F. below zero. This very low temperature is necessary only when sharp freezers are being handled. With a great amount of coil surface, it is possible to maintain a room temperature as low as 25 deg. below zero.

In operating a compressor under such severe conditions, it is almost impossible to prevent freezing up at times. The best plan to follow when working on very sharp freezers is to feed the ammonia to the coils for a short time (from ½ to 1 hr.) then shut off the feed and pump down. The pumping down process will require about twice as long as the feeding. This intermittent feeding and pumping down gives the ammonia a chance to evaporate and does not allow liquid to collect and go to the compressor in slugs.

At zero gage pressure and the corresponding temperature of 27 deg. below zero, a pound of liquid ammonia will absorb 592.5 B.t.u. during evaporation. This means that one pound of ammonia fed into the evaporating coils will take up 592.5 heat units; but all this heat is not taken from the produce in the cold storage room. Before the heat from the room can pass to the ammonia in the coil, the temperature of the ammonia itself must be lowered to the point that corresponds to the pressure in the coil.

We will say that the liquid passes through the expansion valve at a temperature of 85 deg. F. Then to lower the liquid temperature will require that $85 + 27 = 112$ heat units be absorbed from each pound. So the actual amount of heat taken from the produce will be $592.5 - 112 = 480.5$ B.t.u. At this low pressure and temperature, the ammonia is very light and each pound leaving the coil, after absorbing sufficient heat to cause evaporation, will occupy 17.87 cu. ft.

Now we will consider a back pressure of 15 lb. gage. At this pressure the temperature is zero and a pound of ammonia will absorb 572.2 B.t.u. Taking 85 heat units from this leaves 487.2 B.t.u. as the actual amount of heat absorbed in useful work. This is 6.7 B.t.u. more than what is taken up by the pound of ammonia at zero gage pressure. The loss takes place in the useless work that must be done in lowering the temperature of the ammonia itself.

At 15 lb. pressure, a pound of ammonia will occupy 9.19 cu. ft., or but little more than half the space occupied by a pound of the zero pressure vapor.

The foregoing facts show plainly why the higher back pressure is the best when compressor capacity is considered. The higher the pressure at which the ammonia is evaporated, the greater the weight displaced by the compressor. Of course the ammonia is not in a saturated state after it passes through the suction valves and comes in contact with the hot surfaces of the cylinder, valves and piston. It is really a superheated gas.

Now we will see how much difference there is in the volume of a pound of vapor after the superheating. At zero gage pressure and superheated from the saturated state to 50 deg. F., a pound will occupy 20 cu. ft. At 15-lb. gage pressure and superheated 50 deg., a pound will occupy 10.41 cu. ft. By this comparison, we see that the superheating affects the high and low back pressure about the same. When the ammonia at both back pressures has been subjected to the same degree of superheating, the volume of the gas at the high pressure is still about half as great as at the low pressure.

Constructing a Concrete Freezing Tank

Utilizing Old Steel Tanks as Forms in Making New Concrete Tanks. By W. A. Darter

THE HISTORY of concrete freezing tanks is not encouraging and today the subject of making a concrete tank is not regarded at all favorably by the average engineer. The concrete tanks installed so far, as a whole, have not been successful; but I believe the time is fast approaching when concrete freezing tanks will become safe and economical investments.

This company after a great deal of investigation and much argument on the part of the superintendent has seen fit to install a small, 30-ton tank. In making the decision, two points were considered: first, whether the concrete tank would be a safe investment and second, what would be the difference between it and a steel tank, financially.

In considering the first point, the company decided that by using an old steel tank (now discarded because of rusted out places) as a form, the proposition would be a safe one. It was assumed, that even if the concrete tank did crack from end to end or crosswise the old patched up painted steel tank would prevent the brine from leaking out into the insulation.

The difference in cost between the concrete tank and steel tank was estimated to be around $1500, which difference on an investment no larger than this, would warrant some risk.

Preparing the Old Steel Tank to Receive the Concrete

THE OLD steel tank had seen 28 yr. of service and was 44 in. in depth. The new tank had to be 48 in. in depth; 6 in. was allowed for the thickness of the concrete bottom, hence the depth of the old tank had to be increased 10 in. The bottom of the old tank was ¼ in. steel and the sides were ⅛ in. steel. The rust was thoroughly cleaned off the old tank by chipping and using a steel wire brush and was then washed down with a mixture of half turpentine and half gasoline. This mixture has the advantage of not only cleaning off grease spots, but the turpentine will penetrate the rusted out holes and make it easier for the damp resisting paint to take hold. The tank was then given two coats, inside and out, 48 hr. apart, of good damp resisting paint.

Designing the Concrete Tank

IN DESIGNING the concrete tank, three things were considered: first, the mixture of the concrete, second, the thickness of the walls, and, third, the amount of reinforcing. All three of these are so tied together that they cannot be considered separately. The better the mixture and material, the less thickness of walls required, and the thinner the walls are made, the greater the amount of reinforcing rods necessary. And, vice versa, the thicker the walls, the less the linear feet of reinforcing necessary, and to some extent, less cement per cubic foot is necessary. The happy medium in this case proved to be a 6-in. wall with reinforcing spaced 12 in. apart, with ⅜-in. twisted steel rods, and a mixture of concrete of one part cement, one and one-half parts of sand, and three parts of crushed rock, averaging from one-half inch to one inch in diameter. A proportion of 1-2-3½ would have given a good mixture, but to have the best, the above mixture was used. The reinforcing rods should not be spaced more than twice the thickness of the walls apart; i.e., if the walls are 6 in. thick, the reinforcing should be spaced not more than 12 in. apart.

Installing the Reinforcing

AFTER THE paint was thoroughly dry, the sides and end of the tank were drilled, as shown in Fig. 1, in order to rivet the reinforcing supports.

The supports were placed 4 ft. apart in two rows as shown. The first row was placed 6 in. from the top and the second row was placed one foot below the first row. The supports also anchor the sides of the steel tank to the concrete wall, which is necessary in order to keep the sides of the steel tank from pulling away from concrete. If the steel walls become separated from the concrete walls and water happens to get in between the two and freezes, the expansion has a tendency to force the two farther apart and one of them has to give way.

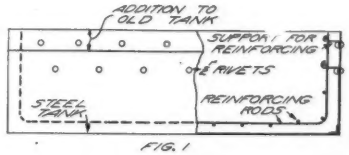


FIG. 1

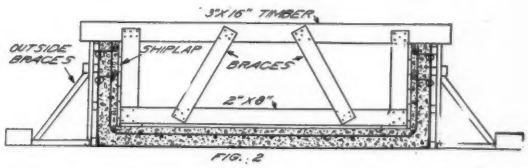


FIG. 2

FIG. 1. SHOWING METHOD OF DRILLING AND PLACING REINFORCING RODS

FIG. 2. METHOD OF SUPPORTING FORM

The supports were made of strap iron ⅜ by 1 in. and riveted with ½-in. rivets. The end of the support is curved in order to hold the reinforced rods running horizontal. The rods running horizontal, lengthwise and crosswise along the sides of the tank, are placed over the other rods in order to increase the strength of the walls.

The rods should be placed a little nearer the inside of the walls because the greatest strength is required at this point due to the greater expansion and contraction. The rods are tied together at each crossing with small iron wires.

Making the Forms for the Tank

WITH THE reinforcing rods in place, the forms are now installed. They may be installed in sections or built in one piece. The form must be supported from the top of the tank from heavy timbers running from one side to the other as shown in Fig. 2.

On the bottom the form should extend out at least

1 ft. or more in order to keep the liquid concrete from bulging up when the walls are poured.

The steel tank as a form must be well braced from the outside to keep the weight of the concrete from forcing it out. The greatest amount of bracing is needed half way between the top of the tank and the bottom all the way around it. If any part of the steel tank is allowed to bulge out, then upon removing the braces, it will have a tendency to pull away from the concrete walls and leave an open space between the concrete wall and steel tank.

The Concrete Mixture

The concrete tank should be as strong as possible with necessary density, the strength and density depending upon the correct selection of aggregates and upon the proper proportioning. Good sharp sand or screenings from crushed rock or gravel screened through ¼-in. mesh wire should be used with crushed rock or gravel averaging from ¼ in. to 1 in. in diameter. Aggregates like these will mix 1-2-3½, or better, 1-1½-3. The ideal mixture is where just enough sand is used to fill all the interstices between the rocks and just enough cement is used to fill all the interstices between the particles of sand; if a denser concrete is wanted, just enough hydrated lime, or similar material is used to fill all the interstices between the particles of cement. Just enough water should be used to give the mixture a quaky, jelly-like consistency. It should not be sloppy.

Mixing and Pouring the Concrete

The concrete should be mixed in a power-operated batch mixer. It is very necessary thoroughly to mix the concrete and it will require at least 1½ min. in a good mixer. The time used in mixing cannot be overdone, but the time is usually limited by the amount of concrete required, in a given time, to pour the entire tank without an interruption.

In making a concrete tank, some engineers will start pouring the concrete around the outside of the tank, and work toward the center; and after the bottom is poured, begin pouring the walls before the concrete in the bottom begins to set. This is a dangerous method, because sometimes the engineer will not get the bottom poured before concrete on the outside begins to set; and as a result the concrete does not combine well at this point, and a weak place is left in the tank where it needs to be strongest. The place to begin is in the center and pour to the outside, and then the walls. The temperature of the outside should be low but not freezing. This will keep the contraction of the tank down when it is put into service. As the concrete is poured into the forms, it should be well spaded, and pudded in order to eliminate the air pockets and cause the concrete to enter all corners in the forms. Rapping the sides of the forms will assist the concrete in settling into a compact mass.

Hardening and Curing of the Concrete

About 36 hr. after the tank is poured the inside forms can be removed. However, the exposed parts of the fresh concrete should be kept wet until the concrete cures. The best way to cure the tank is to fill the green tank with water and let it set for at least two weeks. If the tank is filled with fresh water, the outside braces must not be removed, for the green concrete may not be strong enough to hold the pressure of water against the sides. After the water is withdrawn, the tank should have at least three weeks in which to dry. If the tank is not thoroughly dried before it is painted and put into service, the moisture will freeze and cause the concrete to disintegrate and crumble. After the tank is dried out, it is considered good practice to paint it well with an acid brine-proof paint.

Conclusion

In designing the tank, it is very important to eliminate all bolt holes and grooves in the concrete, for they tend to form weak lines along which the tank would have a tendency to crack in case there are strains. In this tank, the bulk head is set in a raised groove along and on the bottom. The agitator trough is built into the wall of the tank, and a vertical agitator is set into the built-in box and requires no supports from the wall.

The reinforcing rods should not be too near the inside of the tank walls. If they become exposed, they will rust and gradually force the concrete from around them.

The evaporating coils should not be placed too near the concrete and subject the concrete at that point to a much lower temperature than the average temperature of the brine. No moisture must be left in the concrete and no water should be in contact with the outside of the walls to freeze and expand.

The tank should be well insulated from the foundation. If the foundation is not well insulated, it may freeze and buckle up and cause the concrete tank to crack, and a cracked concrete tank is a bad proposition.

Sometimes it is necessary to patch the concrete tank in a comparatively short length of time. In this case the concrete should be mixed with salt brine from the freezing tank. This concrete will set and not freeze, and become almost as strong as any other concrete. The hardening of the concrete can be hastened without impairing its strength by using 1½ lb. of calcium chloride per sack of cement.

Engineering as a Prosperity Insurance*

The Engineer's Part in Establihing the Future Prosperity of the Nation. By George Otis Smith, Director U. S. Geological Survey

It was a chemist who recently summed up the situation thus: "We have science enough now to provide a beautiful, happy, and good world. What shall we do with it?" And my answer tonight is simply—what science has discovered, engineering must apply.

What we seek for our country is welfare rather than wealth—happiness, in fact, rather than greatness in name. To strive for well-distributed happiness and to promote the general welfare are aims that belong in the code of the engineer who raises his life work to the level of a contribution to the future.

Prosperity will fail to satisfy us unless it is backed up with guarantees of permanence. Whatever we are to enjoy this year and next we wish our children's children to enjoy in equal, if not in larger measure. Can we take out nation-wide insurance to cover this forward-looking wish?

*Abstract of lecture delivered before the Engineers' Club of Philadelphia.

My conviction is that the future of our nation will be largely what engineers make it, and the surplus that can be paid to other generations of Americans will depend upon what the engineers of today write into that endowment policy.

The nation, like the family, can safeguard its future by habits of thrift, in fact our national wealth has been accumulated in that way; as a nation we have produced more than we have consumed. We need now to think of production, simply because without production we cannot consume. Thus the rule of action restates itself: To insure the nation's prosperity, we must insure the nation's industry.

Industry is a reaction into which raw material and energy enter; it is the function of engineering to use both material and energy in the smallest quantities possible.

We never hesitate to admit the fact that our ancestors were wise enough to pick out the best part of the best continent in the world to live on. Yet the possession of greater wealth in natural resources only makes us trustees on a larger scale and places on us the duty to pass this real estate on to our children in first-class condition.

Within the last half century, the country's output of coal has increased more than 20 fold, iron more than 23 fold, and copper 68 fold, while the flow of petroleum has increased not less than 700 fold. Forty years ago when the Geological Survey was created, our per capita consumption of crude petroleum was half a barrel a year. Now it is three-and-a-half barrels. This rate of increase is nearly twice that of the per capita consumption of coal in the same period. Federal geologists estimate that while in 100 yr. less than 1 per cent of our coal resources have been exhausted, in only 60 yr., apparently 40 per cent of the available oil in the United States has been consumed.

Before figuring the life of our coal resources, however, you must set down the fact that the best and most accessible coal is mined first, and that as time passes we may expect for the coal of our future output decreasing quality and increasing cost. If coal is mined at the present rate, the exhaustion of the largest coal-bed in Pennsylvania, the Pittsburgh coal-bed, must be measured by the span of a single generation. Expressed in human units, the estimates for the life of the Pocahontas field in Virginia and West Virginia, is three or even two generations; and these fields produce our choicest industrial coal. In Ohio, Indiana, and Illinois, the outlook is better, but the coals are poorer.

The increase in the utilization of natural gas has also been both rapid and steady. An increasing number of citizens are enjoying the use of this best of fuels, while industry's share is being distributed in larger units. Natural gas, however, is a mine that is largely worked out—it has seen its best days—and its future dividends to the nation can not equal those of the past.

And so we might run through the whole list of essential mineral raw materials as well as the products of the soil. In these we are rich beyond compare, but the builders and operators of modern industry can not afford to be spendthrifts.

Human energy was something that the ancients spent with little regard. Today, we regard man-power as something to be conserved, not only because of the high value we set upon humanity, but also because we have learned that in much that we try to do man-power is the limiting factor. Everywhere a man is saved from unessential work is one more man-power added to the strength of the nation.

Forty million horsepower is a conservative estimate of the total power now developed in the United States, 77 per cent of which is steam and 19 per cent water, the remaining 4 per cent representing power generated by internal combustion engines. Seventy per cent of the available water power is west of the Mississippi, while 70 per cent of the water power now installed is east of the Mississippi. With the largest power market and largest power supply so separated, fuel power must continue to carry its part of the load.

The super-power plan that is now being advocated for the great industrial regions of the East seems a direct answer to the appeal for the best use of America's coal. This is a plan for linking up the high power, high economy generating stations with a super-power transmission line for distributing the power wherever it is needed.

It would be well for America if some great engineer, with power of persuasion, could go up and down this country and convince our citizens of the economic needs of an industry which will produce more than it consumes, of the advantage of large unit operation, of the value of an improved load factor and of the fact that the center of the earth is not an inexhaustible reservoir of oil and gas.

To reduce the amount of domestic waste, the public utility engineer must educate his customers. S. S. Wyer asserts that domestic consumers commonly waste 80 per cent of what they buy.

The many questions relating to the production and distribution of commodities essential to life and comfort; the working out of the equities of partnerships between capital and labor and the public are all practical economic issues to which the engineer can bring an analytical mind.

The coal industry furnishes, perhaps, the best example of how the operators, the mine workers, and the consumers are all tied together in actual interest. The curve of weekly coal production tells the story of highly irregular operation, and idle plants and idle men are expensive taxes upon the community and the nation.

For the three months this last spring, the coal mines of the country were operated on an average for only about 24 hr. a week. The reason for lost time was "no market." Here again reduction of the consuming public may accomplish much in bettering the conditions of demand. The public interest lies in a longer working year, not in a shorter day or week. The average working days per year for Ohio, Indiana, and Illinois for the last five years has been 176, 196, and 206 respectively.

The daily average coal consumption of large power companies varies considerably throughout the year. The storage of anything like a reasonable tonnage of coal at such plants could exert a helpful influence on the market, even if they bought their supply from day to day. The influence of such consumers is well worthy of consideration. With their co-operation, much could be done to smooth out the curve of coal consumption and the pooled purchase of coal would further help to abate the seasonal demand which is today the greatest evil in the coal industry.

Calculating Cost of Heating and Ventilation

THE FOLLOWING illustrates one method of finding the cost of heating and ventilating for an average season.

One of the group of buildings in our plant, of which the diagram is an illustration, will be taken for an example. The building contains 5 stories, each 14 ft. high. In this section of New England, an average outdoor temperature of 35 deg. F. prevails during the heating season, which will average about 7 mo., or 200 days, when heat is required to some extent.

As 70 deg. F. is an average indoor temperature in most cases, the heating system must raise the temperature of the rooms 70 — 35, or 35 deg. F.

Multiplying the length of the north wall, 220 ft., by the height, 14 ft., gives 3080 sq. ft. total area. As each window is 4 by 10 ft., and there are 23 windows, the glass area is $4 \times 10 \times 23 = 920$ sq. ft., leaving a net wall area of $3080 - 920 = 2160$ sq. ft.

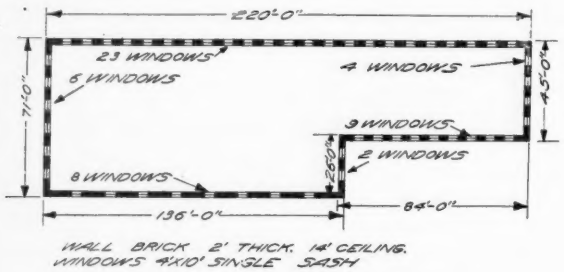


DIAGRAM USED FOR AN EXAMPLE

The factor of heat loss generally used for a 24-in. brick wall is 14 and for a window with single sash 84, making a loss of $(2160 \times 14) + (920 \times 84) = 107{,}520$ B.t.u. per hr. Correcting this for a northern exposure by multiplying by the factor 1.32, gives 141,926.4 B.t.u.

As the building construction can be considered only fair, the foregoing heat loss is multiplied by the factor 1.3, making $141{,}926.4 \times 1.3 = 184{,}504.32$ B.t.u. per hr.

Taking up the other walls, in like manner, with the proper factors as multipliers for the different exposures, a total heat loss of 395,079.77 B.t.u. is obtained.

For different exposures, the multipliers are as follows: North, 1.32; south, 1; east, 1.12; west, 1.2.

The foregoing is assumed to be the heat loss when the system is provided with an automatic system of regulation. In our case, the system is hand regulated and, as a result, there is a greater loss of heat due to such regulation. The total heat loss as calculated should now be multiplied by 1.5 for hand regulation, giving 592,619.7 B.t.u. When automatic regulation is used, the factor is 1.1.

To the total loss for the five floors add the heat loss of the roof, which is found to be the area of the roof in square feet times the factor 0.4 for each degree difference in temperature, or $35 \times 0.4 \times 13{,}436 = 188{,}104$ B.t.u. for a gravel roof. The total heat to be supplied to the building equals 3,151,203 B.t.u. per hour.

In our case, it has been found that best results are obtained by heating the buildings at night with live steam, in very small quantity, being rarely required during the day.

It has been found that, during the average heating season of 200 days, 10 out of the 24 hr. per day was ample to supply heat. Multiplying the total heat loss per hour, 3,151,203 B.t.u., by 10 and 200 = 6,302,406,000 B.t.u. loss for the season.

As the same boilers that are used for power supply steam for heating a test was run to determine the operating results and it was found that we could average utilizing 9000 B.t.u. per lb. of coal. This makes the coal chargeable to the heating system equal to the heat loss, $6{,}302{,}406{,}000 \div 9000 = 700{,}267$ lb. coal. As coal is generally bought on the long ton basis, this equals 313 tons, which, at $10 per ton, cost $3130. To obtain the total cost, the cost of labor and water, with supplies, should, of course, be added to this.

When ventilation is supplied the heat necessary to raise the temperature of the entering air to that of the room can readily be found from the formula: heat required $= \frac{C \times T}{55}$, in which C = the number of cubic feet of air supplied per hour, T = the rise in temperature of the air supplied, and 55 = the number of cubic feet of air 1 B.t.u. will raise 1 deg. F. per hour.

Having a building 150 by 100 ft., with ceilings 12 ft. high, and four floors, the cubical contents of the building is $150 \times 100 \times 12 \times 4 = 720{,}000$ cu. ft. If we supply three changes of air per hour, we handle $720{,}000 \times 3 = 2{,}160{,}000$ cu. ft. of air.

If the outdoor temperature is assumed to be 35 deg. F. and indoors 70, then the air must be raised 70 — 35 = 35 deg. F. This means that $720{,}000 \times 35 \div 55 = 458{,}181$ B.t.u. must be supplied. If 9000 B.t.u. per lb. of coal burned is utilized, we will burn $458{,}181 \div 9000 = 50.9$ lb. per hour. $50.9 \times 10 \times 200 = 101{,}800$ lb. of coal, or $101{,}800 \div 2240 = 45.45$ tons, at $10 per ton cost $454.50 for ventilating for one season. RECEIVER.

Future Engineers

I READ with interest the article entitled "Future Engineers," by H. A. Cranford, in the June 1 issue of Power Plant Engineering. I believe if we had more men of his caliber, who would take an interest in the men

under them, we could eliminate, to a great extent, the trouble we have in getting men to take an interest in their work.

It seems to me there is something wrong with the young men of today. They do not appear to be interested in their future at all. The lure of high wages, short hours, clean work, and a soft job, is too great for them; they don't seem to realize that they will some day be old men without a trade, and perhaps not physically able to do the job-work which they so eagerly sought in their younger days. Even if they should be physically able, very likely they will not get the high wages that they are getting at present and common labor jobs may not be so plentiful 15 or 20 yr. from now. But getting them to see it that way is the proposition.

If I could get them, I would employ only young men who look forward to the day when they can hold down my job, or even something better. When I find a young man who is willing to make the necessary sacrifices in order to learn his trade, I take an interest in him and do all I can to help him along. In fact, nothing affords me greater pleasure than helping the young fellow who is trying to help himself; and if he will just do his part, I will bring him right up to the door of my job.

I believe if more men, whose duty it is to direct the work of others, would take an interest in their men, encouraging them and boosting them along, we would get a better class of men and more of them.

ED. A. FULLER.

Successful Belt Treatment

I THINK A. Waldron has the right idea in regard to belt dressing. Four years ago I took charge of a plant and the two main drives had been bothering my predecessors for 3 yr. The belts were rough and gummed up. I gave them a heavy treatment of prepared chalk while running, and at the end of the week scraped off what remained of the old dressing. I then applied a mixture of castor oil, two parts and neatsfoot oil, one part, once a week for several weeks. Now we use it about twice a year. The belts have not been tightened for 5 yr. and are in splendid shape too, but rather loose.

W. B. MCCLOUD.

Filing Magazine Articles

HAVING TRIED many different methods of filing choice pages from the old Practical Engineer, and the present Power Plant Engineering, I find the following to be the best in every conceivable manner. With a pair of pliers and a knife I remove the steel wire clasp that binds the magazine. That permits spreading out the pages single, or double; using a paper knife as desired. Next the preferred pages are placed in a loose-leaf binder. With a blue pencil each page is numbered from 1 up, one of my binders containing 899 pages.

In the back of the binder I have 23 sheets of unruled white paper, same size as the clippings. These sheets are headed A, B, C, etc., XYZ on one sheet.

Looking on index page A, I find Alternators in Parallel 666. Alternator Slip 544. Now under S is also shown Slip 544.

Looking on index page B, I find Belt Slippage, cause, 272, and so on all through the alphabet.

Any small item that is of importance is not cut and carried in an envelope, pigeonhole, or any other place, but the whole page is placed in the binder, the item properly listed in the index and I can bring it into view within a minute; the only search necessary is to scan the index and then turn a few pages.

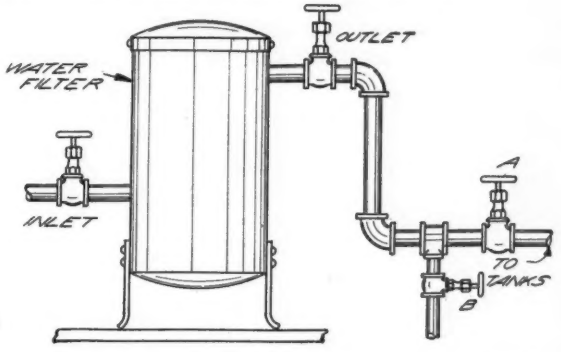
There is less labor necessary to compile a volume in this manner than any other I have tried, and after it is completed it is like finding any article in a first-class indexed book.

Should the original item not carry a caption, it is easy to give it one with your blue pencil and so list it in the index.

J. B. DILLON.

Cause of Automatic Water Tank Valve Leaking

IN A large steam laundry two large water tanks are used for furnishing hot water to the wash machines. The water to the tanks is controlled by two 2-in. automatic water valves. These valves used to cause much trouble on Monday mornings by sticking and leaking for a few hours so that the tanks would overflow.



ARRANGEMENT TO PREVENT TROUBLE WITH AUTOMATIC WATER VALVES

The management of the plant were under the impression that, as the valves were closed from Friday night until Monday morning, during this time rust and scale would form in the valves, then when they were opened, this rust and scale would prevent them from operating properly. After this, the valves were cleaned on Monday morning before using; but shortly after the water was turned on, they leaked as badly as before. Then my attention was called to the matter. In taking them apart, I found much fine sand in them. I also knew at once where the sand came from, as before the water goes into the tanks it passes through a water filter in which different grades of gravel are used as filtering material. It is the practice in this plant to wash the filter at the end of each week's run. In washing the filter, the flow of the water is reversed, so as to run the dirty water into the sewer. I found, after investigating, that more or less of the fine gravel would find its way into the pipe leading to the tanks after the filter was washed and the flow of water reversed to the proper way again. On Monday morning when the water was turned into the tanks, this fine gravel would lodge in the automatic water valves, preventing their proper operating until the sand was washed out again by the water passing through them.

To prevent this trouble, I placed the valves A and B

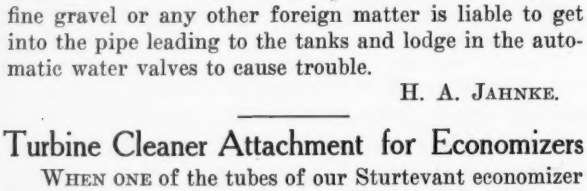
in the water line leading to the tanks as shown in the illustration. Now, before washing out the filter, the valve A is closed, after the filter is washed and all valves closed or opened so the water will flow in the right direction again. The valve B is opened for a short time until all the sand and other foreign matter is removed in the pipe between the valve A and filter, then valve B is closed while valve A is opened. In this way, no fine gravel or any other foreign matter is liable to get into the pipe leading to the tanks and lodge in the automatic water valves to cause trouble.

H. A. JAHNKE.

Turbine Cleaner Attachment for Economizers

WHEN ONE of the tubes of our Sturtevant economizer burned out recently, we discovered that the tubes and headers were badly in need of cleaning. We had trouble cleaning the top and bottom headers, manifolds, and U-tubes, due to the fact that our turbine cleaner would not negotiate sharp bends.

After trying several methods without success, I finally made an attachment for the cleaner, as follows: Four short pieces of light chain were fastened together with a piece of wire and attached to the cutter head



DETAILS OF ATTACHMENT FOR WATER TURBINE TUBE-CLEANER

of the turbine. Running the turbine, thus equipped, forward and back a number of times, effectually cleaned the curved portions of the economizer.

I afterwards designed a more pretentious fitting for this kind of work. This is shown in the accompanying illustration. Part A, attached to the turbine spindle, carries a flexible shaft, B, 24 in. in length. C is a spiral spring, 1½ in. in diameter, of No. 8 gage steel wire. The flexible shaft drives the cutter head, D, which carries three cutters fastened to the ends of three chains of three links each. With this fitting, our economizer can be cleaned in a little more than 4 hr.

OTTO DORTHEN.

A Peculiar Accident

IN A STATION, well known to the writer, along with other equipment, there are two cross-compound Corliss engines, direct connected to d. c. generators 550 v., 909 amp. each. As the load is not heavy enough to run both engines at one time, a rotary converter being tied in on the same bus, receiving current from the 60-cycle system through a frequency changer, it has been customary to run them alternately, that is, No. 1 today and No. 2 tomorrow.

One day the load became too heavy for the rotary converter, so preparations were being made to get No. 2 into service. The machine was at the time in a position to receive steam at the head-end valve on the high side. The regular routine is to warm them up before starting. The valve was hooked up, the throttle cracked, and so was the engineer's head, or, rather, the latter was badly cut.

Why was that? This is why, or at least the decision reached after studying over the accident. The steam main to this engine is piped from the boiler header with a long bend to the throttle. The throttle valve is of the outside screw-and-yoke type. As there is no drip between the boiler header and throttle and, the weather being unusually cold at the time, the steam was condensed. When the throttle valve was cracked, a water hammer developed, which broke the nut in the yoke, allowing the steam to come partly out, snapping the valve wheel, a spoke of which struck the engineer, inflicting a gash requiring some stitches.

The writer believes that, had the nut been brass or steel, and not cast iron, as it was, the chances are one hundred to one that the accident would not have happened. Without a doubt, had there been a drip between the throttle and the boiler-header, as has been placed there since, the accident never would have occurred.

ERNEST C. HANSON.

Experiences with Water Testing Equipment

FROM time to time, readers of Power Plant Engineering have requested opinions and experiences on the subject of water treatment for boilers. For the last 9 yr. I have used treated and untreated water from a river having the following analysis per U. S. gallon:

	Grains
Total residue	24.79
Total residue (mineral)	20.15
Silica	0.77
Iron and alumina	0.43
Calcium oxide	6.23
Magnesium oxide	2.14
Sulphur trioxide	2.5
Sodium chloride	7.69

In one plant was a softening and filtering equipment which was installed after 5 yr. of operation without treatment. The boilers in this plant were horizontal tubular units, 72 in. by 16 ft., with one handhole in front head. This made it nearly impossible to clean the lower part of shell properly. At the time of installation of the softening plant, we gave each boiler a thorough boiling out with caustic potash three days and with soda ash three days; while this was being done, the top manhole was left open.

When the boiler was cooled, a steam rattler was put through each tube, which took off from 800 to 1200 lb. of scale per boiler, although there was always some left.

Soon after we finished the last boiler, the softening plant was put in operation and things began to happen. All boilers were bagged before the scale was entirely removed. After the boilers were freed from scale, no other trouble developed.

I am in favor of treating water before it enters the boilers with modern filters, as most everything can then be removed except hardness. I think the best results are obtained by softening after the water leaves the filtering beds.

One plant I entered as assistant had three water-tube boilers. The insurance had been cancelled 11 mo. previous, as it was a supply to an electric railroad. The conditions were quite severe. After 5 mo. of hard work, liberal use of soda ash and new tubes, we were able to secure insurance. The chief was addicted to the use of soda ash. When a boiler would show symptoms of foaming, we would double the quantity of soda ash for that day. I never have known this remedy to fail where soda ash is used daily.

In two different plants where I have worked, the best results obtained by the use of soda ash were in horizontal tubular boilers of 120 hp. which were 20 yr. old and had been operated 24 hr. a day. They were absolutely free from scale, pitting or anything detrimental to safe and efficient operation.

In this plant there was no method or determined amount fed to the boiler, but at wash out periods prior to putting in top manhole plate 24 qt. of soda ash were put into each boiler. This was a brewery plant, so you will know that foaming boilers are likely to cause the loss of a whole brew. I never saw any symptoms of foaming or priming when running at 150 per cent of their rating.

While the foregoing method seems crude and undesirable, it produced good results without excessive use of cylinder oil. After 7 yr., the Corliss engine was indicated and the valves were apparently steam tight. An open feed-water heater was used, which operated at 210 to 212 deg. F. The pump and piping from heater to the boilers would clog up with soft scale in 3 mo., which was remedied by maintaining three feed lines, two in working order and one undergoing cleaning.

The last plant that I operated where soda ash was used, gave the best results. It was fed to the boilers at the rate of 8 lb. per hundred horsepower each 10 hr.

These boilers were blown down each morning and after 2 yr. of treatment they were in fine condition and the coal consumption had been reduced 50 per cent. There are boiler compounds that give excellent results where the water is treated inside the boilers.

I will make some suggestions for J. B. in regard to his process if they have not already been tried. First, mix the coagulant and settling chemicals with the water and let it pass to filter; then to softening tank. If the water is softened before it goes to filtering beds, it will take three or four times more coagulant to do the work.

GROVER C. WETHERBEE.

Taking Advantage of His Opportunities

I HAVE BEEN a subscriber to your valuable magazine for the past 4 yr. and I should have written to you before now. I owe many words of praise to your staff and your valuable paper.

I first subscribed to keep in touch with up-to-date plant equipment. The plant of which I have been chief for the past 7 yr. was very much lacking in instruments so necessary for efficiency. I would discuss these instruments with my superintendent, but it was first cost with him. They are all the same in that respect. It costs too much.

After getting a number of copies of Power Plant Engineering, I began to tear out pages that had a cut or advertisement of what I thought would best suit the plant and sent them to the superintendent. I sent quite a few, but received no approval. However, I did not give up; I needed them. On the fan case of one of our heating systems we have U-tubes. I borrowed one of these and connected it to one of our stokers, which are underfeed. The firemen, becoming acquainted with it, connected it to one boiler after another until it was nearly worn out from going the rounds.

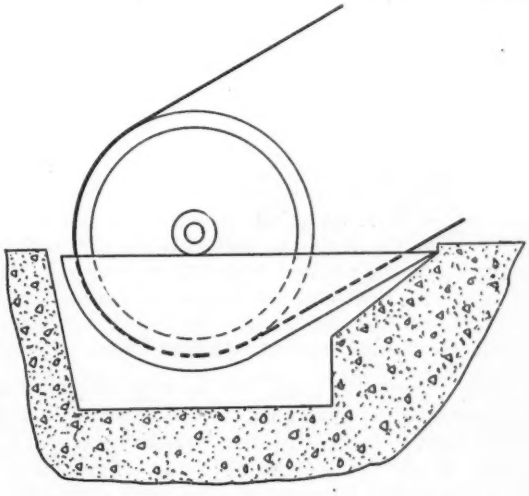
After talking the boss to a standstill and tearing up all the books, I can say that I have a plant fairly equipped with instruments. The U-tube, which cost about 75 cents, is now replaced by four three-in-one precision draft gages and one indicating, integrating and recording steam-flow meter on each boiler, and soot blowers on one, with a promise of others. A gas analyzer was also included in the bargain and I am now running a test on a well-known make of boiler feed regulator, with the promise of each boiler being fitted out with a regulator if I can show a saving when through with the test.

I think it pays to be persistent in purpose, if it is a just one. It pays to advertise, and it is well to keep posted on what is going on.

W. J. JANNELL.

Trouble from Water in Flywheel Pits

THE WRITER was, several years ago, connected with a sawmill outfit, on which a 75-hp. engine with flywheel



SHOWING WATERPROOF BOX IN POSITION

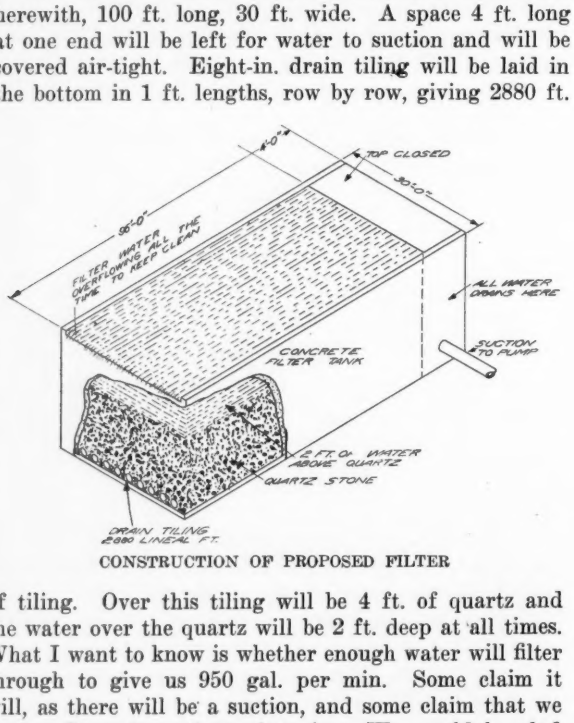
and belt drive was the main unit. In one location, we had considerable difficulty because it was necessary to sink the flywheel into the ground and it was impossible to keep water out of the flywheel pit, even though the pit was made extra deep and provided with a steam ejector. On several occasions the water rose in the pit, soaked the belt and put the outfit out of commission. We finally remedied it by getting a box made up of about the shape shown in the illustration, which we put down in the pit around the flywheel, waterproofed the joints and thus protected the flywheel and belt from water. The flywheel might be worked to advantage in many plants where trouble is encountered from water in flywheel pits.

M. A. SALLER.

Is the Filter Big Enough?

OUR OLD filtering equipment needs renewal, so we have decided to make a filter outside to filter water for paper making. The old filters were 9 ft. 6 in. in diameter by 4 ft. 9 in. deep, with 3 ft. 6 in. of quartz stone for filtering. We have nine such filters. The water is sucked from the bottom through filter heads, of which there are many. Water is pumped in at the top of the quartz and the filter is open on top.

We want to build a filter outdoors, as illustrated herewith, 100 ft. long, 30 ft. wide. A space 4 ft. long at one end will be left for water to suction and will be covered air-tight. Eight-in. drain tiling will be laid in the bottom in 1 ft. lengths, row by row, giving 2880 ft.



CONSTRUCTION OF PROPOSED FILTER

of tiling. Over this tiling will be 4 ft. of quartz and the water over the quartz will be 2 ft. deep at all times. What I want to know is whether enough water will filter through to give us 950 gal. per min. Some claim it will, as there will be a suction, and some claim that we need a filter three times that size. We would be glad to hear from the readers of Power Plant Engineering who have had experience with this kind of a filter.

J. T.

Two Questions for Discussion

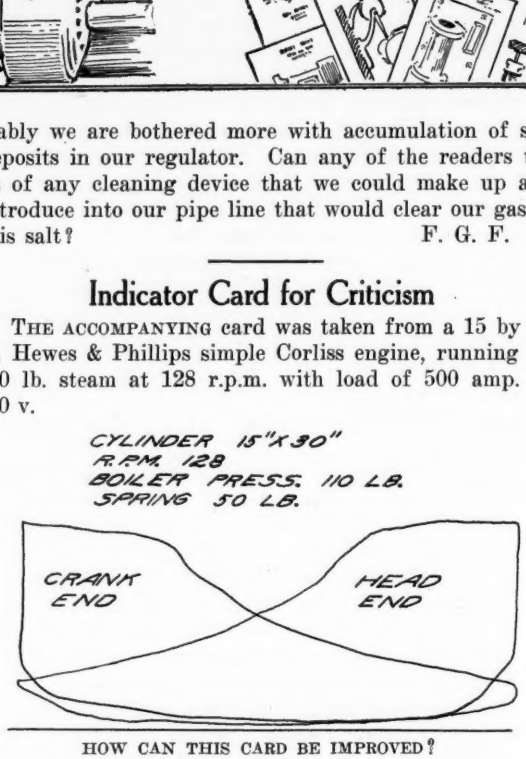
DOES ACTUAL commercial use justify the argument sometimes made against the design of a chain grate type stoker that too great a difference in air supply exists over the fuel bed from the time it enters the grate until it falls into the ash pit, the argument being based on the thinner fire and less resistance offered by the burned fuel at the back of the grate?

We have our own natural gas supply for use with our gas engine and since the pressure has decreased appreciably we are bothered more with accumulation of salt deposits in our regulator. Can any of the readers tell us of any cleaning device that we could make up and introduce into our pipe line that would clear our gas of this salt?

F. G. F.

Indicator Card for Criticism

THE ACCOMPANYING card was taken from a 15 by 30 in. Hewes & Phillips simple Corliss engine, running on 110 lb. steam at 128 r.p.m. with load of 500 amp. at 230 v.



HOW CAN THIS CARD BE IMPROVED?

I would like to submit it to the readers of Power Plant Engineering for suggestions and criticism.

J. S.

Synchronizing Difficulties Caused by Instrument Errors

READING some of the accounts of synchronizing troubles published in recent issues of Power Plant Engineering brings to mind some of the experiences we have had in one plant.

On one occasion, we were unable to throw one of our generators in parallel with running machines without causing much system disturbance and a decided grunting of the incoming machine. We were at a loss as to the cause of this, for great precautions were each time taken to throw the switches of the incoming machine only at the proper instant as designated by our synchroscope. Investigation, however, revealed the fact that the dial of the instrument was off over ¼ in. and after this was corrected, no more trouble was encountered.

Then, again, and that after the synchroscope had been corrected, I have noticed this same machine act as before. Further investigation revealed no such defect as in the other instance and as a consequence, the entire operating force has been at a loss as to the cause of this peculiar behavior of the machine.

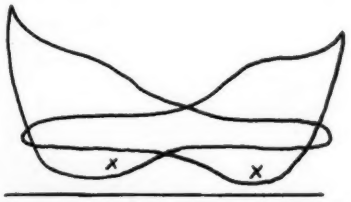
I wonder if some of the readers of Power Plant

Engineering would care to advance an opinion as to the possible cause of our trouble and suggest a possible remedy. J. M. E.

Remedy for Dashpot Trouble

On page 584 of the June 1 issue, R. N. D. tells about his dashpot troubles and invites suggestions. He does not state whether he has vacuum or dead weight dashpots. He has looked for most of the well known causes, but my advice to him is to give this dashpot as little oil around the plunger as possible; in fact, I have had vacuum dashpots that I could not give any oil, because when I did my troubles with bouncing started at once. And with a double eccentric engine having long range cutoff, we must remember that when the dashpot is hard down, the steam valves can have but slight lap, and in some cases only 1/16 in.

Now, it will be seen that if the dashpot holds up a little, it opens your steam port and if a multiported valve, it will admit a lot of steam, so if the engine load is light and steam pressure high, you will have to watch your engine for over speeding. In my case, I have had to stand by the throttle more than once. This makes a very bad state of affairs. If the main belt should break, the governor is powerless, even though it may rise as high as possible. I believe many flywheel wrecks have been caused by bouncing dashpots. I was fortunate



CARD FROM AN ENGINE ON WHICH DASHPOTS BOUNCED

enough one time to get a card from my engine while cutting such capers, which is given herewith.

It will be seen that the valve was held open, keeping the back pressure line up and blowing through at the same time until the positive closing block closed the valve at X X. My experience has been that this oil closes the space around the plunger and entraps the air, causing the plunger to bounce; and also that too much oil gets down in the body and clogs the vents. If the dashpot body does not heat up, I would let the pot starve for oil. It is taken for granted that his stuffing boxes are not too tight, also that his steam valves are getting good cylinder oil. A. C. Waldron.

Boiler Explosions: What Caused the Bag

I take great interest in the articles appearing in Power Plant Engineering, and hoping they may be of interest, I submit the following comments. I. B. Leavitt asks for more details regarding the explosion described by C. S. Tompkins in the May 1 issue. It would seem, from the poor design of the patch and the poorer practice of operating the boiler with the longitudinal seam exposed to the fires, that the explosion was the very obvious result of bad engineering practice all around.

A few years ago, in a Southern state, a boiler inspector found an almost new boiler patched in the manner described by Mr. Tompkins. The insurance company promptly canceled the policies covering, not only this boiler, but all the boilers in the battery. The result was that the firm owning the boilers went to the firm who made their boiler and had a new sheet made, thus eliminating the patch.

I have been much interested in the answers, and while it would be difficult to say what caused the bag in this particular instance as described by J. A. H., I have known of several peculiar happenings of this sort. Two boilers that had been standing idle for several months were prepared for service, being thoroughly cleaned inside and out. The bottom manhole plates were put in place and the boilers filled with a hose through the top manhole. After being in service for about 5 hr., a bag about the size of a scoop shovel showed up on the front sheet of one of the boilers. After cooling down and opening the boiler up, it was found that the bag was caused by sand which had accumulated on the sheet over the fire. The presence of the sand in the boiler was accounted for by the fact that the supply pipe from the city mains was dead ended at the plant and as there was no circulation except when plant was operating, the sand had accumulated in the pipe and was carried over through the hose when filling the boiler. Another instance was on a Mississippi River steamboat. The boilers on this boat had been opened up and cleaned and had been left open for about a week. They were hurriedly filled. Steam was raised as quickly as possible and the boat left port. Within 30 min., she put back again with the front sheet of one boiler so badly bagged that it was necessary to put in a new sheet. Upon opening the boiler, no evidence of scale or mud was found on the bagged portions of the sheet.

S. F. Cavender.

Bearing Trouble Eliminated

In regard to indicator cards published in the March 1 issue, I will say that Roy R. Winan's suggestion was good. We have been operating the high pressure side of a simple engine for some time, disconnecting connecting rod, eccentric gear, shutting off steam from receiver, and exhausting by additional piping. We are developing the same power, the low-pressure bearing is satisfactory and the engine runs much quieter than before.

The cutoff on the low-pressure side was not controlled by governor. X. Y. Z.

Locating Ammonia Leak

We have a double-pipe brine cooler which leaks. The brine came through to compressor and shut us down. The first sign of the leak was a strong smell of ammonia in the brine tank and shortly the brine stopped the compressor.

I have tried to locate the leak, but failed; removed brine returns on coils and applied 80 lb. of air pressure on the ammonia coil, but failed to discover any leaks in ammonia pipe or gasket.

Do you think the suction of the compressor might create any greater pressure on the gaskets than the air which I applied? It seems as if the air would indicate the point of leakage.

It must be the coil that leaks, for we have no trouble

with the compressor nor do we notice any odor of ammonia in the brine tank after cutting out the coil.

R. T. J.

A. As I understand the question, the plant has a cold storage where the brine circulating system is used. The cooling of the brine is accomplished by means of the double-pipe brine cooler and also by coils in the brine tank.

If the plant is connected up in this way the leak must be in a coil in the tank instead of in the double-pipe brine cooler.

There can be a small leak in one of the tank coils and the back pressure has been low enough to allow brine to flow into the coil. This could be the case if the machine had been shut down for a few hours or more. Before shutting down, the main liquid valve was closed and the low-pressure side of the system was pumped down to about atmospheric pressure. After the machine was stopped, the suction valves were closed. The heat of the brine in the tank would then cause evaporation of the ammonia still in the coils and this would cause the pressure to rise enough for ammonia to escape through the leak and pass into the brine. This will account for the smell of ammonia in the brine tank.

After the ammonia had left the coil, the pressure would be reduced enough to allow the brine to enter. If the brine tank is deep, the weight of the brine will exert some little pressure on the outside of the coils at the bottom of the tank.

When the machine was again started up, the brine in the coil would go through the suction line to the compressor and cause the shut down. This slugging of the compressor may not occur immediately on starting the machine, as the brine can lodge in a pocket in the system.

To test for a leak in the coils of the tank, it is safest to shut the outlet or suction valve and feed ammonia in through the expansion valves till there is about 40 lb. pressure on the coils. Remove the covers of the tank and if there is a leak, a sharp crackling noise will be heard (like the noise made when steam is turned into cold water).

If the leak is found to be in the coils of the tank, start up the machine and pump down till the crackling stops. Do not pump any longer, as there is danger of slugging the compressor. Connect air to the coils and keep the air pressure on till the brine is lowered below the leak. This is to prevent the coils filling with brine.

If the leak is not found in the tank coils, test out the double-pipe cooler. First disconnect both ammonia and brine inlet and outlet. Then plug one end of the inner or brine pipes and connect the air to the other end. Air will show at the disconnected ammonia pipes if there is a leak. If the leak does not show up, test the other way by putting the air pressure on the ammonia side of the cooler.

The most probable reason for the apparent stopping of the leak was that the machine is operated with a back pressure so low that the weight of the brine in the tank prevents ammonia escaping to an extent that is noticed. The pressure caused by the weight of the brine is just equal to the ammonia pressure inside of the coil.

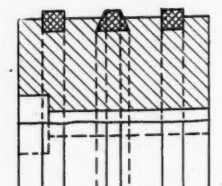
If the leak had been in the double-pipe cooler the brine would go into the ammonia and there would have been no smell of ammonia in the brine tank.

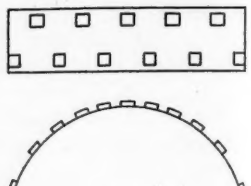
A. G. Solomon.

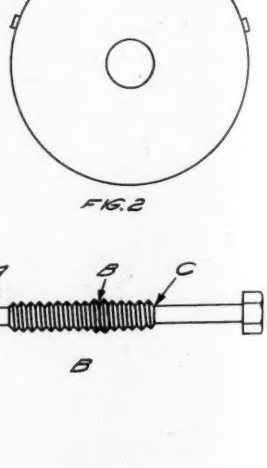
Piston Knock; Operating Engines with Water Wheels

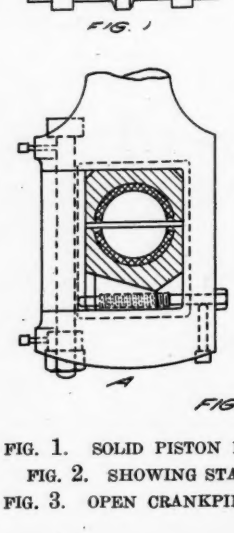
In the April 1 issue, I have noticed J. L. S.'s "Why the Knock?" and in the May 1 issue a couple of answers to the question.

I have had pistons thump around in cylinders in different engines and I do not recommend putting in stiffer springs to remedy the trouble. That is only a makeshift, and should the springs weaken, the same bumping will occur again. It is poor practice to expect springs to hold a piston in place.









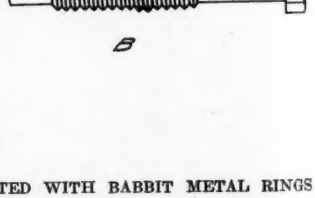


FIG. 3

FIG. 1. SOLID PISTON FITTED WITH BABBIT METAL RINGS
FIG. 2. SHOWING STAGGERED BABBIT PLUGS ON PISTON
FIG. 3. OPEN CRANKPIN BOX, SHOWING DEFECTIVE WEDGE BOLT

If a solid piston, it should be dovetailed as in Fig. 1 and filled with first quality babbit metal or red metal, and turned to a proper fit.

I have used both babbit and red metal with success on solid pistons, and have had new junk rings made to fit on built-up pistons.

In one case where the piston lifted, I staggered babbit plugs on top, as in Fig. 2, and it worked perfectly.

An experience that I had with a vertical engine may be of interest to other readers. The crank end was a "hatchet head," Fig. 3, and only one wedge bolt was used. The engine had a tail rod with an eye in the end to assist in making adjustments and repairs. This tail rod and eye saved the day. A wedge bolt broke and was replaced, but the engine pounded so badly it could not be operated. The new bolt was pulled up tightly but still the pound was there.

Finally after several hours work, testing the wrist-

pin boxes, crosshead shoes, and about every possible thing imaginable, the falls were coupled on the tail rod and a good strain put on. The rod was lifted ¼ in. or more, and the lost motion was in the crankpin boxes, where the new wedge bolt had been put in. The bolt was removed and the wedge tried for clearance. It was fully an inch from striking, and the boxes were open ⅜ in.

Then it was discovered that the thread at B, Fig. 3B, was oversize. Something had caused the lathe to let the tool back or the work to spring away and the thread would not enter the wedge at this point, regardless of the pressure applied on the head of the bolt. A new bolt cured the difficulty in about 20 min.

The tail A is left long enough to butt on side of rod, which prevents a shut-down in case of broken bolt. These breaks occur at end of thread C regardless of filleting, if the valve gear skips caused by rounded steels on cutoff toes.

In the May 1 issue on page 495 E. E. A. asks about operating an engine with water wheels. I have seen three engines and seven water wheels tied in together, and they worked well. The whole secret in successful operation is to have a first class water wheel governor that will handle the wheels at the power wanted; in other words, a governor that will open the gates to seven, eight or nine-tenths, more or less, as set, and still be capable of closing the gates should no load condition prevail. The trouble with a compound engine in connection with water wheels is that if the wheels take too much load, the receiver pressure drops and there is danger of cutting the cylinder or wrecking the valve gear.

It is wise to build up the receiver pressure regardless of the balancing effect, for lubrication purposes, and decidedly unwise to carry a load so light that receiver pressure cannot be maintained.

I gained this knowledge through the experience of having to rebore a low-pressure cylinder, simply on account of the load falling to the point where the wheels carried about 90 per cent, and lubrication practically stopped in the low-pressure cylinder.

TOM THUMB.

Some Massachusetts Questions and Answers

WHY IS lap used on a single-eccentric Corliss engine?

2. Is lap used on the exhaust valve of a single-eccentric Corliss engine? If not, why? Is lap used on a double-eccentric engine?

3. If you had to renew the tubes of a return tubular boiler, would you start from the center and work outward or would you start at the top or bottom?

4. Why are the tubes of water-tube boilers flared? Why on fire-tube boilers are they beaded?

5. Kindly explain the operation of the Holly system.

6. What is an equalizer on a boiler and how is it put on? V. E. B.

ANSWERS

WE HAVE your letter, and in reply submit the following information:

1. Lap is put on the steam valve of a single-eccentric engine to govern the length of the steam admission, and consequently the amount of steam admitted to the cylinder.

2. Marks' "Mechanical Engineers' Hand Book" gives a table showing exhaust lap on a number of typical Corliss engines as being negative. This means that when the wristplate is in a central position, both exhaust valves are open a small amount. This is to reduce compression which is not required to be high in a slow moving engine, such as the Corliss.

3. In renewing the tubes of a return tubular boiler, it would probably be more convenient to renew those nearest the shell first. There is no particular point, however, at which the start should be made.

4. Tubes are flared in water-tube boilers for the reason that it would be difficult to get at the ends to bead them. In the case of a fire-tube boiler, if the tubes are not beaded but simply flared, the edges, which would be subjected to intense heat without having any way of transmitting this heat to the water would be likely to be burned off. Where the tubes are beaded, the ends are forced into contact with the tube plates and consequently are enabled to transmit the heat to the water.

5. The Holly System consists essentially of a discharge chamber connected to the boiler by two pipes, one to the steam space and one below the water line. The discharge chamber is further connected to a receiver located at the lowest point in the piping system, and into which all condensate drains. Steam is supplied to the receiver at sufficient pressure to raise the water to the level of the discharge chamber. The discharge chamber is vented to allow for the exhaust of the non-condensible gases. A small amount of steam is also allowed to pass through this vent, slightly reducing the pressure in the discharge chamber and assisting the water in passing from the receiver to the discharge chamber. The pressure being equalized in the two connections to the boiler, whatever water remains in the discharge chamber will fall by force of gravity to the boiler.

6. An equalizer is an arrangement for equalizing the load on the various supports of a boiler when the boiler is supported at more than two points on each side. It might consist merely of springs being placed between the heads of the supporting bolts and the stationary supports or an arrangement of levers supported at their centers on the setting, the ends being attached to the lugs on the boiler shell.

Calculating Diameter of Pump Steam Cylinders

CAN YOU give me the rule used for determining the required diameter of steam cylinder for a boiler feed pump? A. A. F.

A. Kent gives the following formula for calculating the diameter of the steam cylinder of a direct-acting pump:

$$D = d\sqrt{\frac{p}{EP}}$$

where D is the diameter of the steam cylinder, d is the diameter of the pump cylinder, p is the resistance per square inch on the pump and equal to 0.433 times the head in feet, E is the efficiency of the pump and P is the steam pressure in pounds per square inch.

THERE MUST be output before there can be income.—Forbes Magazine.

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Water Power Waste Can Stop

At last we are to have the chance to develop the water power of our navigable streams and public domain. For a long period we have allowed thousands of horsepower of energy to run to waste while we dug into our coal supply with ever-increasing rapidity.

The stated reason has been to safeguard the public interest in the natural resources of our rivers. And politicians and reformers have quibbled over fine points of law and of verbiage, failing to do the obvious thing—appoint a commission of experienced and dependable engineers to state the elements of the problem and its solution.

Four elements are involved: Development of hydroelectric power; irrigation; storage of water for power and for manufacturing and domestic supply; development of rivers for navigation. In some cases one feature, in others another, is the controlling factor. A careful engineering survey would determine in any case what rights of the public were of importance to safeguard, and it is unlikely that any one set of rules can be made to cover all cases. Power is generally assumed to be the object desired by those wishing to undertake a development. But several cases are known where the interested parties would gladly provide a dam and whatever the government may demand in the way of improvement of navigation so long as they may have opportunity to irrigate the lands which they control. And they will turn over the water power interests to the government or any lessee which it may name. It has done great harm to raise a hue and cry about the avarice of "big water power interests." For a development of any size, the interest must be big or it cannot finance or construct the project. And certainly nobody will invest in such a project unless he can see a probable return on his investment commensurate with the risk taken, and a reasonable safeguard of his capital. The only powers with which a waterpower bill is concerned are big ones, and their development could not be accomplished with a lot of picayune restrictions attached.

The bill as passed by Congress has been carefully considered for many years in various forms, and objections of the first forms submitted have been overcome to the point where agreement was reached.

In its final form, the bill provides for a Federal Power Commission to serve as a clearing house on hydraulic development questions. This commission is to have broad powers including judicial decision, investigation and licensing of projects. This is large power, and may be abused, but great responsibility has always been found to breed caution and conservatism. Publicity in regard to its actions would seem to furnish a deterrent to any biased or unwise course which might be proposed. The only limit to the activity of the Commission would seem to be the size of appropriation given it, and this may possibly be augmented by the establishment of a sinking fund from the revenues for the rental of power sites on public lands.

Limiting provisions of the bill are that preference be given to municipalities over private organizations in the granting of licenses and permits; licenses are limited to 50 yr. unless renewed; the United States shall do the work rather than a licensee if the Commission determines that to be advisable; engineering and

construction must be approved by the Commission and the profits must be reasonable and controllable by the Commission; combinations to limit output or restrain trade are prohibited, and the character of the improvement is to be determined by the Commission whether the facilities to be provided were intended by the projector or not.

Construction has to be started within 2 yr. after the granting of a license, and after a license has expired the Commission can take over a project on 2 yr. written notice, paying for it an amount equivalent to the net investment. If the government does not exercise its right, a new license can be issued on expiration of the old one. In time of war, government can take over the use and control of any project, paying a reasonable compensation. Safeguard is also provided against snap granting of a license or permit.

The restrictions and safeguards would seem to be adequate. The development of our waterpowers is needed, and it is likely that within 2 yr., from 200,000 to 2,000,000 hp. will be in process of reclamation from waste. This will be an improvement not only for our own generation, but for all time, and it is matter for rejoicing that the door has been opened for our municipalities and private interests to proceed to get results. Too long have one or a few men been able to hold back this advance in the utilization of one of our greatest natural assets.

Off Duty

"Say, Bill! Get the cloud observer on the wire and ask him whether we can shut down unit No. 3."

A moment later, Mr. Cloud Observer in his perch on the roof of the power plant, picks up his binoculars and after scanning the horizon for a while, reports a dark cloud to the north and notifies the "chief" that he had better keep No. 3 running for a while.

Shades of CO_2! Cloud observer? What next!

Well, we won't venture to say what will be next; but it is a fact that a cloud observer has actually been stationed in Chicago and if his eagle eye detects a dark cloud rising up over the north side, he knows that in a short time 15,000 incandescent lamps will be switched on. Of course, an incandescent lamp is nothing very great considered as a load, but when we get 15,000 of them going all at once, it constitutes quite an appreciable load. So before this sudden increase in load can take them by surprise, the cloud observer sees to it that another turbo-generator is cut in to handle it. This must be great sport—beating the weather to it.

In our estimation, a cloud observer has a soft job, however useful he may be to the company, and we suggest that somebody invent a pair of automatic signaling binoculars, which would serve the same purpose as the above-mentioned individual, thus allowing him to get off from his perch to stretch his legs.

Speaking of binoculars reminds us of another development along that line—or rather in the line of monoculars, for the glass we have reference to has only a single eyepiece. (Yes, mono means one).

To be sure, it is different in other respects also; for one thing, it is a bit larger. Some 99 in. larger in diameter than the average pair of field glasses. Perhaps a bit heavier, also, and we could hardly tote it up to the roof of our power plant to keep tab on clouds—the tube alone weighs 35 tons. In fact, our 50-ton crane in the turbine room could hardly negotiate the new 100-in. Hooker reflecting telescope of the Mt. Wilson observatory—the most powerful yet constructed.

The mirror, which was cast in France at the St. Gobain works, is 101.3 in. in diameter and 12 in. thick. This mirror and its supporting elements lie in a massive steel cell which bolts to the telescope tube. Since the variation in temperature alters the figure of the mirror, the mirror and its cell have been surrounded with an inch of corkboard and means are provided to control the temperature within the enclosure. Brine, the temperature of which is automatically controlled by a thermostat, is circulated through coils lying under the mirror. Fans circulate the air all around the mirror and coils. The brine is heated by electrical coils, and cooled by ammonia expansion coils.

The worm wheel which is used to drive the telescope at a constant rate to compensate for the apparent daily motion of the stars is 200.53 in. in diameter and has 1440 teeth. It is so accurately ground that there is no periodic error as great as 1/100,000 in. Gosh! Our micrometer on that, would be about as crude and clumsy as a two-foot rule for measuring turbine clearances.

A marvel of perfection, isn't it? Yes, somebody says, but why spend so much time and money on a mere telescope—a spy glass. Of what practical use is it? Will it earn any money?

Of what use? Of tremendous use, we answer.

The observatory of today resembles any other place of business. It is no longer the secluded place where a few "queer" scholars sit hour after hour gazing at the stars. Indeed no. The modern observatory is an intensely active place—plans are laid, machines are devised and built, and the whole run on schedule time. Problems are attacked in the same manner as in a laboratory, a factory, or a power plant. One investigates, for example, the problem of light absorption in space in much the same manner that the problem of lubrication would be studied.

How is it that a huge ocean liner leaves Liverpool today, and a week later steams unerringly into Ambrose Channel, New York? By astronomical navigation. And why is this method of navigation possible? Who construct the complicated tables and star maps used therein?

Who gives us the correct time? Who compiles our almanacs and our calendars? The astronomical observatories. Are they useful? Well, we guess yes—more indispensable than many of our more familiar modern conveniences. Do they earn money? Well, why speak of money in the same breath with the knowledge these marvels of science bring us?

But we have sort of strayed away from what we started out to talk about—and now it's about time to get back on the job. However, don't let us become so interested in our work around the power plant that we forget that there are other things in this world besides boilers, and CO_2 that are of value. It does us good to look around once in a while and to talk about the other fellow's work at the times when we are Off Duty.

Federating the Engineering Societies

ONE of the most important meetings of engineers that has been held in the United States, assembled in Washington, June 3-4, to take up the question of forming a federation of the engineering societies of the country. To this conference came representatives of over 70 organizations, representing great national associations of engineers and local associations from New England to the Pacific Coast and from Minnesota to New Orleans. Each organization was entitled to at least one representative, and the larger organizations to one for each 1000 members. There were 119 delegates present, representing over 100,000 engineers.

The meeting was called by a Conference Committee composed of representatives from the four oldest national societies, representing civil engineering, electrical engineering, mining and metallurgy and mechanical engineering, this committee having worked in compliance with the report of committees from the various societies advising the formation of some inclusive organization to stand as a national representative of the engineering profession.

At the outset, the question arose as to the purpose of the new organization and whether it should be an organization of individual engineers or a federation of societies. There was little debate as to the purpose which was stated in a resolution presented to the conference to be the furthering of public welfare and of the interests of engineers and engineering, the greater importance being placed on the welfare part of the work as affecting national, state and local legislation and construction. There was considerable debate as to the membership by individuals or by associations, but, as it became evident that the majority favored membership by associations, the vote on this point was made unanimous in favor of such membership.

The conference then resolved into committees on credentials, program, constitution and by-laws, and resolutions, and adjourned until such committees were ready to report. The committee on program adopted, largely, the preliminary program which had been laid out by the conference committee, but reserved the right to change that program as circumstances might make desirable. There was, however, little change in the program during the two days' session of the conference, except as to the order of presentation of some of the addresses.

In order to save the time of the conference, a tentative draft of constitution and by-laws had been worked out, embodying the recommendations of the committees of the four societies which had called the conference; but this entire draft was carefully gone over by a committee on constitution and by-laws, consisting of 25 delegates representing all sections of the country, all classes of engineering societies, associations and clubs, national, state and local, and all shades of opinion.

After the provisions had been passed upon by this committee, they were taken up item by item by the conference assembled and subjected to debate and ratifications, and it speaks well for the unanimity of opinion of the conference that not more than three or four changes were made in the new constitution and by-laws as reported by the committee. The provisions of the constitution and by-laws are appended at the end of this article.

The importance of this conference can hardly be overestimated. It has been said of engineers that they cannot co-operate, or at any rate that they do not, and that this has been the reason why engineers have not had the influence and standing in the community to which the importance of their professional work entitles them. While it is one of the first requisites of a successful engineer that he shall be able to co-operate with other individuals, it has unfortunately been true in the past that engineers have not co-operated well with each other. There have been many associations in which those engineers interested in a particular part of the field have worked together for common good and advancement, but there has been lack of co-operation between the different branches of the profession and between engineers in separate localities.

In contrast to this has been the attitude of the legal and medical professions who for many years have in all-inclusive, local and national societies been speaking for those professions as a whole and carrying great no medium through which differences of opinion might well be considered as authorities. When engineers have spoken on public questions, it has been as individuals or as representing small aggregations and there has been no medium through which differences of opinion might be reconciled, so that there would be a united front in making recommendations as to public policy or legislation on questions involving expert engineering knowledge.

Harmony of thought and co-operative spirit was at all times in evidence at the Washington conference and this indicates that engineers are now learning the necessity for co-operation and the method of securing it, by sinking individual preference in the effort for the common welfare. An organization which can speak as representing the expert opinion and mature conclusions of over 100,000 of the best engineers of the country will undoubtedly be able to exert great influence and will do much to establish in the thought of the country the importance of the profession and its right to speak authoritatively on matters in which engineers are the best qualified of all professions to render opinions. While there were differences as to methods that came up during the conference, it is notable that in the end, after all sides had been heard, every action taken was agreed to unanimously, and in the final vote on the adoption of the constitution and by-laws—in which 67 societies were represented—there was no dissenting vote.

In closing the conference, the further question of organization, receiving of applications of membership and the calling of a meeting of delegates for the final organization of the council and the election of officers was left in the hands of the Conference Committee, and it is also requested that Engineering Council should, as in the past, carry on activities for public welfare and co-operative effort until the new American Engineering Council is in position to take over this work. It seemed to be the feeling of the meeting that there was no criticism to be made of Engineering Council, which has done many creditable things. Its misfortune has been that it has been too modest and its accomplishments have not been sufficiently well known; but it was felt that to speak for the engineers of the country a more inclusive body is needed and one which is more representative in organization, and the Federated American Engineer-

ing Societies, which will be organized under the new constitution, will have such an inclusive organization and such wide representation in its management that it will fairly represent all sections of the country and all branches of the profession. It can hardly be doubted that the new Federation and its operative machinery, the American Engineering Council and Executive Board, will carry to high success the work so auspiciously begun in Washington.

The provisions of the constitution and by-laws follow:

That the name shall be the Federated American Engineering Societies and the purpose is to be to contribute to the public welfare, to further the interests of the public through the use of technical knowledge and engineering experience and to act upon matters common to the engineering and allied technical professions.

That membership shall be by organizations, and affiliations, national, local, state and regional, of engineers and allied technical professions. A local organization having 100 or more members may join direct. Or it may affiliate with other local organizations, and the affiliated body may join, having a delegate for each 1000 members or major fraction thereof. Local sections or branches of a national organization are represented through the delegates of the national organization, but the local branches of several national organizations may affiliate as a local organization, and this affiliation may join the Federated American Engineering Societies and have its own delegates on the Council. Each delegate has one vote.

Management is to be vested in the American Engineering Council and its Executive Board. The Council will consist of the representatives of the Member-Societies, selected by such method as each society may determine on the basis already outlined. National Societies will have one representative for each 1000 members or major fraction, the maximum number for any society being 20 representatives. The Council is to hold an annual meeting, and other meetings may be called by the Executive Board or must be called on written request of 25 representatives on the Council.

Officers are a President to hold office for 2 yr., four Vice-Presidents to hold office for 2 yr., two to be elected each year, and a Treasurer to hold office for 1 yr. Officers are to be elected by letter ballot of representatives on the Council. The executive officer who will also be Secretary will be appointed by the Executive Board and hold office during its pleasure.

The Executive Board will consist of 30 members. The President and Secretary of the Council will serve also as Chairman and Secretary of the Executive Board, and the vice-presidents and treasurer will be members of the Executive Board. The remaining 24 members will be appointed between national and local member-societies on the same ratio as the representatives on the Council. Selection of the members for the local, state and regional societies will be by the representatives on the Council according to electoral districts based upon membership and area, the districts to be determined and outlined by the Council and Executive Board.

Representatives on the Council will serve for 2 yr. and members of the Executive Board for 1 yr.

Regular meetings of the Board will be held monthly except during July and August, and special meetings may be called by the Chairman or on written request of five members of the Board.

Committees are to be appointed on Procedure, Constitution and By-Laws, Publicity and Publications, Membership and Representation, Finance and Public Affairs, with the usual duties and to serve 1 yr.

Funds are to be raised by the payment of contributions by each Member-Society, $1.50 per member for national societies and $1.00 per member for local, state and regional organizations and affiliations.

Meetings of the Council, the Board and Committees are to be public, except executive sessions.

Any Member-Society may terminate its membership on June 30 or Dec. 31 by giving 3 months' written notice to the secretary if all dues have been paid. Societies represented by delegates at the conference were declared eligible to charter membership, and the American Society of Mechanical Engineers reported as accepting membership, and the American Institute of Electrical Engineers reported as ready to join.

Other provisions relate to the usual duties of officers and the routine methods of carrying on the work of the Council and Executive Board.

News Notes

WHITFIELD P. PRESSINGER, New York, vice-president Chicago Pneumatic Tool Co., died June 10 as a result of complications following an operation. Mr. Pressinger was actively engaged in the pneumatic tool and allied machinery industry for many years. He was general manager of the Clayton Air Compressor Co. for 7 yr. and became widely known through numerous activities in the American Society of Mechanical Engineers and the Compressed Air Society. He was born in New York City in 1871. In addition to the foregoing societies he was a member of the Sons of the Revolution, 7th N. Y. Regiment Veterans, F. and A. M., and the following clubs of New York City: Engineers, Lawyers, New York Athletic, New York Railroad, Columbia Yacht and the Machinery Club.

THE NATIONAL RESEARCH COUNCIL, a co-operative organization of leading scientific and technical men of the country for the promotion of scientific research and the application and dissemination of scientific knowledge for the benefit of the national welfare, has elected the following officers for the year beginning July 1, 1920: Chairman, H. A. Bumstead, professor of physics and director of the Sloane physical laboratory, Yale University; First Vice-Chairman, C. D. Walcott, president of the National Academy of Sciences and secretary of the Smithsonian Institution; Second Vice-Chairman, Gano Dunn, president of the J. G. White Engineering Corporation, New York; Third Vice-Chairman, R. A. Millikan, professor of physics, University of Chicago; Permanent Secretary, Vernon Kellogg, professor of biology, Stanford University; Treasurer, F. L. Ransome, treasurer of the National Academy of Sciences.

THE ANNUAL CONVENTION of the National Association of Stationary Engineers will be held at the Milwaukee Auditorium Sept. 13 to 17, inclusive.

For exhibition purposes, this auditorium can not be excelled, being large, well lighted and well ventilated. Hours of admission will be from 9:30 a.m. to 10 p.m., thus providing ample opportunity for all to view the many appliances on display and to meet local and visiting engineers, manufacturers and dealers.

AT THE annual meeting of the New York Electrical Society, held June 8, officers for the coming year were elected. W. N. Dickinson was chosen president, succeeding Edwin B. Katte. Ernest W. Muller, Charles E. Speirs and J. M. Buchanan were elected vice-presidents.

For the twenty-third time, George F. Guy was elected secretary. He has served in this office almost since the organization of the society. Another re-election was that of Thomas F. Honahan as treasurer.

THE NOMINATING COMMITTEE of the American Society of Mechanical Engineers has reported as nominees for officers to be voted on for the year 1920-21, the following:

For President, Edwin S. Carman of Cleveland, O.; for Vice-Presidents, Leon P. Alford of New York, Joseph Harrington of Kansas City and Robert B. Wolf of Philadelphia; for Managers, Louis C. Nordmeyer of St. Louis, Henry M. Norris of Cincinnati and Carl C. Thomas of Baltimore; for Treasurer, Wm. H. Wiley, of New York.

AT THE annual meeting of the stockholders of the Westinghouse Electric & Manufacturing Co. which was held at East Pittsburgh, Pa., June 9, the following directors were unanimously re-elected for 3 yr.: Guy E. Tripp, Chairman of the Board of Directors of the Westinghouse Electric & Manufacturing Co., New York City; Joseph Marsh, President of the Standard Underground Cable Company, Pittsburgh, Pa.; H. H. Westinghouse, Chairman of the Board, Westinghouse Air Brake Company, New York City; Albert H. Wiggin, Chairman of the Board of the Chase National Bank of New York; George W. Davison, President of the Central Union Trust Company of New York City, who was selected by the Board of Directors to succeed James N. Wallace, deceased, was elected by the stockholders for the term expiring June, 1921.

AT A MEETING of the Board of Directors of the Yale & Towne Mfg. Co., held on May 27, the resignation of John B. Milliken as treasurer of the company, which had been presented at a previous meeting, was accepted. Mr. Milliken resigns to enter other fields.

Willard L. Case was elected treasurer to succeed Mr. Milliken. His election is effective from July 1, although he will not take up his duties until Sept. 1.

Edward C. Waldvogel, who has been in the employ of the company for 15 yr., and who has occupied the position of general manager for 4 yr., having charge of all sales and advertising, was elected a director of the company.

THE ANNUAL report of the Westinghouse Electric & Manufacturing Co. shows:

Gross earnings for the year ending March 31, 1920, of	$136,052,091.63
Manufacturing cost, including cost of sales, of	120,972,261.53
Leaving a net manufacturing profit of	$ 15,079,830.10
There is additional income, which brings the gross amount up to	16,801,163.84
and deduction for interest and miscellaneous expense leaves a net income available for dividends and other purposes of	15,206,341.27

from which dividends, at the rate of 8 per cent yearly, have been declared quarterly.

The current demand for products of the company is recorded as being in excess of the present capacity of the plant; so that if the demand continues, further facilities must be provided.

As to the policy of the company, the report states that the wage scale has been maintained equal to that prevailing in the various localities where its works are located, and has been as liberal as was permitted by the prices obtained for products.

Each employe receives a life insurance policy without cost, and the company has been interested in housing work, maintenance of a co-operative store, the operation of a cafeteria for employes, and a school in which the teaching ranges from the elements of the English language to advanced electrical engineering, with average daily attendance of over 2000. There is also maintained a savings association and an old age pension system.

Trade News

INGERSOLL-RAND CO. of Illinois, and A. S. Cameron Steam Pump Works, Chicago Branch, announce a change in address. Their offices are now located at 709 Fisher Building, Chicago, Ill.

THE YALE & TOWNE MFG. CO. announces the purchase of the Industrial Electric Truck Division of the C. W. Hunt Co., of Staten Island. This business will be combined with the hoist department, and will thus put this company in position to furnish complete equipment for the moving of medium and light loads, either vertically or horizontally.

THE PENNSYLVANIA Pump & Compressor Co., of Easton, Pa., announces the opening of its sales offices in the following cities: New York, 50 Church St., H. C. Browne, manager; Philadelphia, Pa., 2222 Chestnut St., W. J. Devlin, manager; Pittsburgh, Pa., 631 Fulton Bldg, C. W. Gellinger, manager; Richmond, Va., Mutual Bldg., W. F. Delaney, manager; Birmingham, Ala., 2027 Jefferson Bank Bldg., H. I. Kahn, manager; Salt Lake City, Utah, Newhouse Bldg., C. H. Jones, manager; Milwaukee, Wis., 604 First National Bank Bldg., Coates & Zarling, representatives.

GEO. B. CARPENTER & Co., Chicago, Ill., has recently issued its general catalog No. 110, which covers a complete line of supplies for power plants, mills, factories, railroads, mines and vessels, giving the list prices.

THE GRISCOM-RUSSELL CO.'s bulletin No. 1010 illustrates an expansion joint for use on low-pressure steam lines to provide for expansion and contraction of the pipe.

THE CRESCENT BELT FASTENER CO. has recently published a new hand book illustrating belt fasteners in use on many different kinds of belting and under different conditions, and giving full data regarding their use.